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THE PLANT DISEASE REPORTER

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Crops Research Division serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

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The increase in the volume of pertinent material offered for publication in the Plant Disease Reporter has made it necessary to limit the subject matter and the length of articles accepted. The subject matter should emphasize new things in plant pathology, such as new records of disease occurrence, serious outbreaks and epidemics, conditions affecting development of plant diseases, techniques of investigation including instrumentation, new discoveries in control including new materials and their evaluation. Manuscripts will be limited to 12-double-spaced typed pages, including tables, graphs, and photographs. Because of reproduction costs photographs should be kept to a minimum. Insofar as possible, material should be presented as graphs rather than tables. Papers cannot be accepted for publication that report routine control experiments, reviews, bibliographies without annotation, results of routine surveys, mere summaries or lists of plant diseases. By following this procedure we hope to continue publishing all articles promptly.

Paul R. Miller

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THE PLANT DISEASE REPORTER

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CONTENTS

1. Bacterial rind necrosis of watermelon
MAMORU ISHII and MINORU ARAGAKI 761

2. Corn stunt disease in Guatemala
EUGENIO SCHIEBER and MANLIO CASTILLO 764

3. The spread of tristeza in citrus in two Florida counties
HARRY C. BURNETT and J. MILTON BORING. 765

4. Evaluation of flowering crab and certain other apple clones for detecting stem pitting in apples
EARLE C. BLODGETT and MURIT D. AICHELE 767

5. A virus of durum wheat in North Dakota transmitted by leafhoppers
R. G. TIMIAN 771

6. Survival, colonization and antagonism of induced mutants of Chaetomium globosum Kunze
T. H. NICOLSON 774

7. Physiologic races of leaf rust of wheat, Puccinia recondita Rob. ex Desm. f. sp. tritici, in the United States in 1959
C. O. JOHNSTON 778

8. Physiologic races of crown rust of oats identified in 1959
M. D. SIMONS and L. J. MICHEL 780

9. Root rot of white oak in Arkansas
E. RICHARD TOOLE 783

10. Decay 5 years after thinning of sweetgum sprout clumps
E. RICHARD TOOLE 784

11. Action of odoriferous organic chemicals and essential oils on wood-destroying fungi
JASPER C. MARUZZELLA, et al. 789

12. Effects of soil temperature on the pathogenicity of Rhizoctonia solani isolates
R. E. HUNTER, et al. 793

13. Rapid degeneration of some strawberry varieties and selected seedlings infected with latent C virus in combination with other viruses
P. W. MILLER 796

14. Reaction of differential cotton varieties to isolates of Xanthomonas malvacearum in North Carolina
BILL B. BRODIE and W. E. COOPER 800

15. Procedure and effectiveness of the barley embryo test for loose smut used in North Dakota
DONALD J. MORTON, et al. 802

16. Effect of high-temperature water vapor on soil organisms
LEO CAMPBELL and WILBUR D. COURTNEY 804

17. A modified method for culturing elm samples
JOHN H. HART 806

18. Control of banana fruit-spot ("speckle") caused by Deightoniella torulosa (Syd.) Eli.
D. S. MEREDITH 808

19. Aecial stage of bean rust found in New York State
E. D. JONES 809

20. Host Index available (Announcement) 809

PIC

BACTERIAL RIND NECROSIS OF WATERMELON[1]

Mamoru Ishii and Minoru Aragaki[2]

Abstract

Bacterial rind necrosis of watermelon was found to be caused by a species of Erwinia resembling E. carnegieana. The disease is characterized by a light brown, dry, hard discoloration of the rind, occasionally extending into the flesh. Limited host range tests have indicated that other cucurbit fruits are not susceptible.

INTRODUCTION

Bacterial fruit rots of important cucurbitaceous fruits are reported to be caused by Erwinia aroideae, E. carotovora, and Pseudomonas lachrymans (1, 3, 4, 8). On watermelon, known bacterial rots of the fruit appear to be limited to those caused by E. aroideae or its related forms.

In Hawaii, bacterial soft rot of watermelon is not a problem. Among internal fruit blemishes on watermelon observed in Hawaii is vascular browning, a relatively inconspicuous blemish in the region of the vascular bundles of the rind, which has occurred in the drier regions during the past several years. Isolations from such affected bundles have always given negative results; this supports the belief that vascular browning of watermelon is etiologically similar to vascular browning, an important physiological disease of tomato (5). An internal browning of watermelon believed to be caused by continued drought conditions during fruit maturation was described by Gilbert and Artschwager (6). Although internal browning and vascular browning may be etiologically related, the symptoms differ greatly in their severity. Vascular browning is scattered and only affects the immediate region of the bundles, whereas internal browning is more extensive in its effect and can become general and affect the entire rind.

During the summer of 1957 isolated outbreaks of an internal, brown, hard, and dry rind necrosis of watermelon, Citrullus vulgaris var. Black Chilean, were encountered in the Kahuku area on Oahu. Isolations from discolored areas yielded, in most cases, pure cultures of dull white bacterial colonies on beef extract-peptone agar plates. Subsequently, a similar outbreak was encountered during the past summer of 1959 in the Kihei area on the island of Maui. Isolations from affected fruits from the latter source again yielded similar bacterial colonies. Rind necrosis is reported here as a previously unrecorded disease of watermelon.

SYMPTOMATOLOGY

Typical rind necrosis is characterized by a light brown, dry, and hard discoloration interspersed with lighter areas somewhat similar to a fruitlet black rot disease of pineapple (2), more descriptively designated as marbled fruit (7). The disease develops in the region of the rind and at times extends slightly into the flesh. The affected area is occasionally limited to isolated spots localized along the region of the vascular bundles, but generally shows moderate systemic spread following the vascular bundles. In severe cases the discoloration becomes general and at times the entire rind is affected (Fig. 1A).

The symptoms appear to have some similarity to internal browning of watermelon described by Gilbert and Artschwager (6). In both cases the affected areas coincide and cell necrosis is generally confined to the parenchyma cells with the vascular bundles remaining normal in appearance. However, bacterial rind necrosis of watermelon differs from internal browing in that it is caused by a bacterium, and necrosis and hardening of the infected tissue are associated with extensive invasion by the bacteria (Fig. 1B), lignification of the cell walls, and the affected parts have a distinctly unpalatable flavor and mild odor. Moreover, in severe cases, fruit deformity and rugosity are associated with the internal symptoms.

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[1]Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Technical Paper No. 498.

[2]Assistant and Junior Plant Pathologists, respectively, University of Hawaii, Honolulu, Hawaii.

FIGURE 1A. Rind necrosis of watermelon showing systemic spread throughout rind of watermelon experimentally inoculated with bacteria.

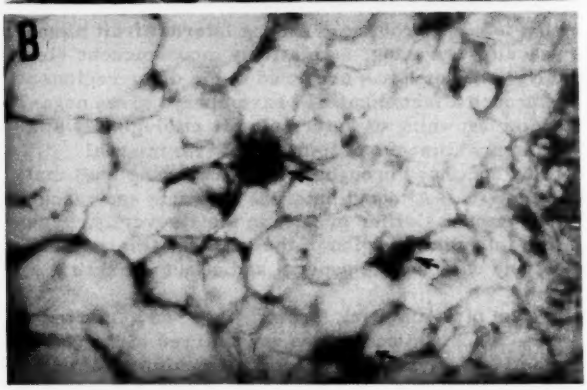

FIGURE 1B. Pockets of bacteria extensively distributed throughout necrotic area.

RESULTS

Pathogenicity Tests: Inoculation tests were carried out by injecting 1/2 ml of a heavy suspension of 24-hour-old cultures in sterile water. Inoculations were made into the rind with a hypodermic needle inserted at an oblique angle to avoid the flesh region. Inoculation sites, one on opposite sides of the fruit, were first swabbed with 70% alcohol, but no seal was used on the puncture sites. Controls were treated in the same manner except that sterile water was used.

Initial inoculation tests conducted in 1957 were with mature or almost mature fruits of watermelon, variety Black Chilean. Inoculations generally failed to produce typical symptoms on mature fruits. Limited amount of water-soaked browning, generally similar in color and appearance, was observed at the site of inoculation in all cases, otherwise a general watery decomposition of the flesh occurred in varying degrees. Rotted fruits generally manifested a disagreeable flavor and odor not unlike that from natural infections. The bacterium, although not in pure culture, was consistently reisolated from affected areas of the rind of inoculated fruits.

Subsequent inoculation studies were carried out during the summer of 1959 with a new isolate obtained from Kihei, Maui. Inoculations, using identical techniques, were made on 24 fruits, including several varieties of watermelons. Two stages of maturity, approximately 4 weeks and 1 week before estimated harvest dates, were selected for the inoculation of fruits in the field; however, time from inoculation to harvest for the early inoculation series varied from 4 to 6 weeks.

Symptoms on fruits inoculated at near maturity were generally similar to those obtained in 1957 and no typical browning was reproduced, except for a localized area of water-soaked browning at the site of inoculation. Typical brown, hard, and dry necrosis of the rind was reproduced in all cases when fruits were inoculated with the pathogen approximately 4 weeks before maturity. General necrosis, typical of rind necrosis, extended over a large part of the rind at the site of inoculation of inoculated fruits, with extensive systemic browning following the vascular bundles in all directions from the point of inoculation. Browning appeared to be

more extensive on the side resting on the ground. Although traces of browning at the periphery of the flesh could be detected, the flesh was generally normal in appearance. In severely affected fruits the flesh exhibited a characteristically disagreeable flavor and odor. The bacterium was reisolated, in most cases in pure culture, from the systemically affected parts of the rind.

Attempts to inoculate other cucurbits, including Cucurbita maxima, C. pepo, C. moschata, and Cucumis melo, have been unsuccessful.

Morphology and Physiology: Preliminary studies of the rind necrosis pathogen show that the bacterium is a short, gram-negative, non-capsulated motile rod with peritrichous flagella.

Physiological characterization showed that the bacterium did not produce indole, reduced litmus, did not hydrolyze starch, reduced nitrate, produced H_2S, and produced acid and gas from xylose, arabinose, glucose, galactose, fructose, sucrose, and mannitol; acid and gas production slow from lactose. Gelatin was liquefied slowly. These results indicate that the pathogen is a species of Erwinia. Its relationship to other species of Erwinia is as yet not clear; however, it appears to closely resemble E. carnegieana. Specific determination of the bacterium and its pathogenicity on other hosts are presently being studied.

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HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU

PIC

CORN STUNT DISEASE IN GUATEMALA

Eugenio Schieber and Manlio Castillo

Corn stunt, a virus disease of Zea mays also known as "achaparramiento," was found severely attacking corn plantings all over the country. Although the disease was observed by Muller (1) in 1941, apparently it has never been as severe as this year. It appears to have spread not only in Guatemala but also to neighboring countries. In Guatemala the present severe incidence occurred on Indian corn in the Pacific coast and in the Guatemalan highlands. Corn stunt has been observed from altitudes ranging from sea level to 8000 feet, but it was more severe at lower elevations. Recently in El Salvador the same or a similar disease -- based on the description of symptoms in the field -- has caused a general alarm in the country and corn growers refer to the disease as "hoja blanca" of maize since some of the symptoms are the same as the virus disease now prevalent in rice in the area. Present symptoms in Guatemala are the same as described by Muller (1) and by Cervantes et al. (2) in México. Dwarfing is the characteristic symptom although not all plants affected are stunted. The plant has a bushy appearance because of shortening of internodes above the ear and excessive tillering (Fig. 1). Proliferation of ears is common in later stages of disease development and ears do not develop normally. Foliage is a pale green and individual leaves show chlorotic streaks of white or yellow. The margins of the leaves in later stages develop reddish and bronzed color. Abnormal and poor development of roots is common in advanced stages of the disease.

FIGURE 1. Symptoms of corn stunt in a mature plant, showing typical tillering.

The search for resistant material has been initiated at the experimental grounds of the Instituto Agropecuario Nacional. Guatemalan corn lines, together with resistant material from the Rockefeller Foundation program in México, are under test. Recent data seem to indicate that varieties derived from the "Tuxpeño" race of corn in México show a high degree of susceptibility under field conditions in Guatemala.

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INSTITUTO AGROPECUARIO NACIONAL, GUATEMALA C. A.

THE SPREAD OF TRISTEZA IN CITRUS IN TWO FLORIDA COUNTIES

Harry C. Burnett and J. Milton Boring[1]

A number of trees that have been in the Florida State Plant Board Citrus Budwood Registration Program from 2 to 6 1/2 years have recently been reindexed for tristeza. The trees were found to be free of this virus when they were originally entered in the program. In both the indexing and reindexing, seedling key limes were used as indicator plants.

The trees in the Program, 40 in number, were from Orange and Polk counties. When reindexing was completed, 20 trees were then found to be infected with this virus and 20 to be still tristeza free. It is of interest to note the only spread of the disease was in Orange County. In this county, 26 trees were reindexed, of which 20 were found to be infected with tristeza. There were no new infected parent trees of the 14 reindexed from Polk County.

Table 1. Results of trees in Budwood Program reindexed for tristeza from two counties in Florida.

County	Variety	Date of first indexing	Determination	Date of re-indexing	Determination
Polk	Valencia	12/11/53	-	10/20/59	-
Polk	Marsh Grapefruit	1/14/54	-	10/19/59	-
Polk	Marsh Grapefruit	1/14/54	-	10/19/59	-
Polk	Pineapple	1/25/54	-	10/19/59	-
Polk	Orlando Tangelo	1/25/54	-	10/19/59	-
Polk	Pineapple	1/29/54	-	10/19/59	-
Polk	Hamlin	1/29/54	-	10/19/59	-
Polk	Hamlin	1/29/54	-	10/19/59	-
Polk	Pineapple	1/29/54	-	10/10/59	-
Polk	Duncan Grapefruit	1/29/54	-	10/19/59	-
Polk	Hamlin	1/29/54	-	10/19/59	-
Polk	Pineapple	7/28/55	-	10/21/59	-
Polk	Pineapple	7/28/55	-	10/21/59	-
Polk	Temple	7/28/55	-	10/21/59	-
Orange	Parson Brown	6/12/57	-	11/18/59	-
Orange	Parson Brown	6/14/57	-	11/18/59	-
Orange	Pineapple	10/31/57	-	4/22/60	-
Orange	Pineapple	10/31/57	-	1/4/60	-
Orange	Minneola Tangelo	1/26/59	-	10/14/59	-
Orange	Navel	1/26/59	-	10/14/59	-
Orange	Pineapple	1/23/54	-	10/22/59	+
Orange	Hamlin	5/11/54	-	10/22/59	+
Orange	Hamlin	5/11/54	-	10/22/59	+
Orange	Hamlin	5/11/54	-	10/22/59	+
Orange	Hamlin	5/11/54	-	10/22/59	+
Orange	Pineapple	5/14/54	-	10/22/59	+
Orange	Pineapple	5/14/54	-	10/22/59	+
Orange	Pineapple	5/14/54	-	10/22/59	+
Orange	Pineapple	5/14/54	-	10/22/59	+
Orange	Temple	5/14/54	-	10/22/59	+
Orange	Temple	5/14/54	-	10/22/59	+
Orange	Valencia	3/9/55	-	5/20/59	+
Orange	Valencia	3/9/55	-	5/20/59	+
Orange	Murcott	5/19/55	-	4/12/60	+
Orange	Parson Brown	6/12/57	-	11/18/59	+
Orange	Parson Brown	6/12/57	-	4/20/60	+
Orange	Pineapple	10/31/57	-	10/22/59	+
Orange	Pineapple	10/31/57	-	10/22/59	+
Orange	Pineapple	10/31/57	-	10/22/59	+
Orange	Pineapple	10/31/57	-	10/22/59	+

[1]Plant Pathologist and Assistant Plant Pathologist, respectively, State Plant Board of Florida, Winter Haven, Florida.

When reindexing was completed, 9 out of 11 Pineapple oranges, 2 out of 4 Parson Browns, all of the 4 Hamlins, 2 Valencias, 2 Temples, and 1 Murcott were found positive for tristeza. The absence of any spread in grapefruit varieties is not significant, as none were tested from Orange County. Cohen (1) in 1957 reported the spread of tristeza in one Orange County grapefruit grove.

Research has shown this virus is aphid transmissible. Norman and Grant (2, 3) list both the green citrus aphid, Aphis spiraecola Patch, and the melon aphid, Aphis gossypii Glover, as vectors for this virus in Florida.

Table 1 shows results from first and second indexing of trees from Polk and Orange counties.

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STATE PLANT BOARD OF FLORIDA, WINTER HAVEN, FLORIDA

P1C

EVALUATION OF FLOWERING CRAB AND CERTAIN OTHER APPLE CLONES FOR DETECTING STEM PITTING IN APPLES[1]

Earle C. Blodgett and Murit D. Aichele[2]

Abstract

Preliminary screening tests during 1957-1959 showed that some of the flowering crab apples are good indicators for the stem-pitting virus. Tests in 1959-1960 using the fall and spring double bud inoculation technique on 70 crab apple clones, 3 Russian seedlings, Virginia Crab and Spy 227, were evaluated as quick indicators for stem pitting. A tip die-back was consistently associated with these symptoms. Jay Darling, Purple Wave, Eleyi, Evelyn, Irene, Purple Lemoine, Red Silver and Van Eseltine were the best indicators. Positive readings of tip die-back were available in 43 days.

INTRODUCTION

In recent years a widespread and very active interest in virus diseases affecting apples (1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12) has developed. One of the most common of these diseases is stem pitting, described in 1956 (2) and shown to be latent in several apple varieties (10). Several attempts have been made to determine indicator hosts for the detection of this virus (7, 9, 3).

In Washington State, work on the Nursery Improvement Program has indicated a special need for reliable and reasonably quick indexing methods for the detection of latent pome fruit viruses. A large collection of flowering crab apple varieties has been assembled and screened in an attempt to determine whether any plants in this group would be suitable indicators. This paper presents the results of index tests for virus on these crab apple varieties and other apple clones.

MATERIALS AND METHODS

The collection of flowering crab apple varieties (names according to Wyman (13)) was started in 1953. By 1957 a sufficient number had been assembled to begin preliminary screening tests. Trees of 57 clones were propagated on domestic apple seedlings in nursery plots at the Irrigation Experiment Station, Prosser, Washington.

In August 1958 bud inoculations, using apple cultures AP-4, 25, and 26[3], were made on these clones by placing two buds on each of two 1-year-old trees. Non-inoculated check trees were left for comparison. During May 1959, a stunting of growth and a tip die-back was observed on some of the inoculated flowering crab apple trees.

Dr. A. F. Posnette of East Malling Research Station, Kent, England, during his visit to the Prosser plots in July 1959, called attention to the possible association between tip die-back and stem pitting. At this time, however, stem-pitting symptoms as normally expressed in the wood were indistinct. In late August 1959 the bark on these test trees was peeled, exposing most of the tree trunk including the union and lower crown, and stem-pitting readings were taken. Close correlation was shown between tip die-back and stem pitting. In many cases the predominant symptom consisted of necrotic pockets or pits in the bark tissue. In others, most

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[1]Scientific Paper No. 1988, Washington State Agricultural Experiment Stations. Work was conducted under Project No. 1264.

[2]The senior writer is jointly employed by the Washington State University and the Washington State Department of Agriculture. Both writers are Plant Pathologists with the Washington State Department of Agriculture, Irrigation Experiment Station, Prosser, Washington.

[3]In research work on diseases of fruit trees at the Irrigation Experiment Station it has been the custom for the past 14 years to collect cultures of virus and viruslike disorders of apples as found in Washington orchards. The following list of cultures are those used in the experiments reported on in this paper: AP-4, mosaic on Ortley; AP-25, "star cracking" type on Golden Delicious; AP-26, flat apple on Starking; AP-27, fruit deformity on Winesap; AP-28, fruit deformity on Golden Delicious; AP-30, leaf spot on Starking; AP-32, mosaic on Starking; AP-34, fruit and limb deformity on Golden Delicious; AP-39, dwarf growth on Starking; AP-51, mosaic on Golden Delicious; AP-52, russet ring on Golden Delicious; AP-53, early defoliation on Paradise Crab; AP-54, mosaic on Starking.

Table 1. Comparative sensitivity of seven representative crab apple varieties to the stem-pitting virus. The index trees were bud-inoculated in August 1958 and read in September 1959, Prosser, Washington.

Variety	Culture (see footnote 3)	Index host reaction[a]			
		Stem pitting	Stem furrowing	Bark pitting	Stunt and die-back
Irene	AP-4	sv			sv
	AP-25	sv			sv
	AP-26	sv			sv
Jay Darling	AP-4	sv		sv	sv
	AP-25	sv			sv
	AP-26	sv			sv
Lemoine Crab = purpurea lemoinei	AP-4	sv			sv
	AP-25	sv			sv
	AP-26	sv			sv
Purple Wave	AP-4	sv		mod	sv
	AP-25	sv			sv
	AP-26	mod		mod	sv
Hopa	AP-4		sv		sl
	AP-25		sv		sl
	AP-26		sv		sl
Redflesh	AP-4	sv			mod
	AP-25	sv			mod
	AP-26	mod			mod
Strathmore	AP-4				
	AP-25				
	AP-26				

[a]sv = severe, mod = moderate, sl = slight, blank space = no reaction.

FIGURE 1. Purple Wave Flowering Crab Apple used as an indicator host for stem pitting. The plants were inoculated August 1959 and the photo taken May 25, 1960. The three plants on right show the growth from the lower inoculum buds, culture AP-52. The Purple Wave buds near top of seedling died after starting growth. The three plants on left were inoculated with the non-stem pitting culture AP-53. The Purple Wave buds are growing normally.

FIGURE 2. Eleyi Flowering Crab Apple used as an indicator host for stem pitting. The plants were inoculated April 12, 1960 and photo taken May 25, 1960. The two plants on the right inoculated with culture AP-52 show tip die-back on the developing Eleyi shoots. The two plants on the left were inoculated with a mild form of stem pitting, culture AP-28, and at this time show normal growth. The inoculum buds are alive but not growing.

Table 2. Stunt and die-back reaction[a] on 11 apple clones inoculated with 12 apple cultures, in August 1959. Stem pitting readings were made in May 1960, Prosser, Washington.

Apple clone	Cultures (see footnote 3)											
	Checks	AP-25	AP-26	AP-27	AP-28	AP-30	AP-32	AP-34	AP-39	AP-51	AP-52	AP-53	AP-54
Evelyn	0	sv	sv	0	mod	0	mod	mod	sv	sv	sv	0	sv
Irene	0	sv	sv	0	mod	0	sv	mod	sv	sv	sv	0	mod
Jay Darling	0	sv	sv	0	mod	0	mod	mod	sv	sv	sv	0	sv
Lemoine Crab	0	sv	sv	0	mod	0	mod	mod	sv	sv	sv	0	sv
Purple Wave	0	sv	sv	0	sl	0	sl	mod	sv	sv	sv	0	sv
Van Eseltine	0	mod	mod	0	0	0	sl	mod	mod	mod	mod	0	mod
Russian Sdlg. 45-39	0	mod	sl	0	sl	0	mod	mod	sv	sv	sv	0	sv
Russian Sdlg. 65-105	0	mod	mod	0	mod	0	mod	sl	mod	sv	sv	0	sl
Russian var. R12740-7A	0	mod	sv	0	sl	0	mod	sl	mod	mod	mod	0	mod
Spy 227	0	mod	sv	0	mod	0	0	sl	sv	sl	sl	0	mod
Virginia Crab	0	sl	sl	0	sl	0	0	sl	0	sl	sl	0	0

[a] sv = severe stunting and tip die-back, mod = moderate stunting and red spotting of foliage, sl = slight stunting and red spotting of foliage, 0 = no symptoms.

of the "stem pitting" actually consisted of furrows and ridges in the wood. Readings on representative crab apple clones showing stunt, tip die-back, and stem pitting are shown in Table 1. The complete table showing results of the 57 clones tested is available upon request to the authors.

On the basis of this preliminary test, two methods of producing rapid stunt and die-back symptoms in indicator varieties were tried and six of the better crab apple indicators were compared with five other known indicators of stem pitting. The first method involved the simultaneous budding of the inoculum and indicator variety onto apple seedlings in the fall. The second consisted of fall budding the indicator variety on apple seedlings, followed by spring budding of the dormant inoculum below the indicator bud.

In August 1959 buds of the six most promising crab apple clones and five other known indicators were set about 4 inches above the ground on domestic apple seedlings. About 1 week later two buds from each of the 12 cultures listed in Table 2 and described in footnote 3 were set between the indicator bud and the ground. Three individual trees were used for each source of inoculum and several non-inoculated checks were left in the rows. Stunt and die-back readings were taken on May 5, 1960.

The spring inoculations were made on April 12, 1960 in the same manner as the fall inoculations; approximately 70 apple clones were tested. The following cultures were used: AP-25, 26, 28, 34, 51 and 54[3]. For this test stunt and die-back readings were taken on May 25, 1960. In both experiments the seedlings were cut back to the indicator bud just before or as growth started.

RESULTS

The results of the 1957-1959 screening test show that several of the flowering crab apple clones can be used as good indicators of stem pitting in apples (Table 1).

For the 1959 fall inoculation test, all the inoculum buds which had been placed below the indicator buds were growing or alive when readings were made in May 1960. At this time some of the indicator buds had developed stunted shoots, with small red spots on the foliage and in more severe cases the buds began to grow and then died (Table 2, and Fig. 1). Owing to the small size of the indicator plants, stem-pitting readings could not be made. The die-back symptom (Fig. 2) was particularly noticeable when readings were taken of the spring inoculated trees on May 25, 1960. By this date the indicator buds had made 6 to 8 inches of growth. The apple clones exhibiting die-back after spring inoculation were the following crab apples, Malus species and varieties: 1) Eleyi Crab = purpurea eleyi, 2) Evelyn, 3) Irene, 4) Jay Darling, 5) Lemoine = purpurea lemoinei, 6) Purple Wave, 7) Red Silver, 8) Red-vein Crab = pumila niedzwetzkyana, 9) Rose Tea Crab =

hupehensis rosea. With few exceptions, all three inoculated trees in the set showed definite tip die-back. Observations made on June 1, 1960 showed that many of the clones which were inoculated in both the fall and spring tests developed small, puckered and curled leaves. These symptoms were very pronounced and similar to those caused by a heavy infestation of apple aphis.

DISCUSSION

Strains of stem pitting may be indicated, since cultures AP-28, 32, and 34 consistently gave milder reactions on the indicator hosts (Table 2) than cultures AP-25, 26, 39, 51, 52, and 54. The red spots on the foliage and the puckered leaf are regarded as symptoms of stem pitting because of their close association with tip die-back and pitting of the woody tissues.

One of the most valuable findings is that certain of these indicator plants react with definite, clear-cut symptoms of tip die-back. This symptom may possibly be related to the presence of other virus not yet identified, however. Some of the apple clones used in the 1960 spring inoculation test gave a definite die-back reaction in the field after only 43 days. This quick test can be of great value in developing indexing programs for nursery stock improvement.

The crab apple varieties which appear to be the best indicator plants of those tested are: Eleyi, Evelyn, Irene, Jay Darling, Purple Lemoine, Purple Wave, Red Silver, and Van Eseltine. All except Van Eseltine are red leaf types. It is easy to realize the advantage of the red colored foliage when caring for the nursery stock and making index readings.

Of the 13 cultures used in these experiments 10, including 4 with mosaic, have been shown to contain the stem-pitting virus. According to these data and earlier tests by Mink and Shay (9), stem pitting apparently is a common contaminant in apples.

Acknowledgment: Appreciation is expressed to Grant DeVoe and Everett Murray for assistance in the nursery operations and to Gaylord Mink, Purdue University, for furnishing budwood of the three Russian clones.

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PIC

A VIRUS OF DURUM WHEAT IN NORTH DAKOTA TRANSMITTED BY LEAFHOPPERS[1]

R. G. Timian[2]

Summary

A virus not previously reported in North Dakota has been tentatively identified as striate mosaic virus. Durum wheat was the principal host. Symptoms were similar to those previously described for this virus on winter and durum wheats in South Dakota. The virus was transmitted successfully with Endria inimica (Say) but not with Rhopalosiphum fitchii (Sand.), Macrosiphum granarium (Kirby), or Toxoptera graminum (Rond.). It was not transmitted mechanically.

INTRODUCTION

Virus-like symptoms were observed in durum wheat plants in experimental plots at Fargo, North Dakota in July 1959. The symptoms were similar to those described for striate mosaic on wheat by Slykhuis (2) in 1953. Faint chlorotic streaks were observed first on the undersides of the leaves and later the streaks became more distinct and appeared on the upper leaf surfaces. The leaves became progressively more chlorotic and necrotic. Heads usually emerged on infected plants but partial to complete sterility occurred in most plants. Under greenhouse conditions infected plants were 75 to 100% sterile. Infected plants were stunted, but the amount of stunting apparently depended on the age of the plants at infection. Symptoms of the disease were observed in hard red spring wheat and rarely in barley. Smooth brome (Bromus inermis Leyss.) plants in grass runways and in forage grass plots on the Fargo experiment station showed symptoms similar to those observed in durum, but the brome plants were more chlorotic and stunted than the durum plants.

The disease occurred in the eastern one-fourth of North Dakota, western Minnesota, and southeastern Manitoba, Canada.

The disease was observed in all durum varieties examined at the Fargo experiment station. Differences in symptoms among varieties were not discernible. In durum fields, up to 25% of the plants showed symptoms of the disease. Commonly, the disease was most prevalent along field borders. Generally, infection was less in hard red spring than in durum wheat fields. However, a cover crop of the former at the Fargo experiment station was almost 100% diseased in October 1959.

TRANSMISSION STUDIES

Attempts to isolate a pathogen on a potato-dextrose agar medium from roots and tops of infected plants failed[3].

Evidence indicative of mechanical transmission was not obtained by rubbing sap from infected plants on carborundum-dusted leaves of barley and durum wheat.

Leafhoppers, particularly the painted leafhopper (Endria inimica Say)[4], were abundant in North Dakota during 1959. Six species of leafhoppers were identified from collections made in the fall at Fargo, North Dakota. The population was comprised of approximately 90% E. inimica; the remainder were largely Macrosteles fascifrons (Stål.) with smaller numbers of Psammotettia lividellus Zett., Exitionus exitiosus (Uhler), Graminella nigrifrons (Forbes), and Cicadula ciliata (Osb.). To determine whether a causal agent could be transmitted by insects, caged and uncaged seedling durum plants were placed in the plots where numerous diseased

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[2]Plant Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

[3]The author wishes to thank D. J. Morton and R. J. Cook for their help in attempts to isolate a causal organism.

[4]The author is indebted to R. L. Post and G. Senechal of the Entomology Department, North Dakota State Experiment Station, for identification of the leafhoppers.

plants had been observed. At various time intervals a pot of each of the caged and uncaged plants was placed in the greenhouse after being sprayed with an insecticide. Some plants in all the uncaged pots developed disease symptoms. Symptoms were first observed 14 days after the plants were placed in the field. No aphids were observed on the test plants at any time during the test feeding period.

Leafhoppers collected from the field were placed on seedling durum plants in the greenhouse and allowed to feed 48 hours, after which the plants were sprayed with a nicotine sulfate insecticide. Checks consisted of durum seedlings on which leafhoppers, collected from the North Dakota State College campus bluegrass lawn, fed for an equal length of time. After 3 weeks some plants in each of the pots except the checks showed symptoms of the disease. None of the plants in the check pots showed symptoms 5 weeks after the leafhoppers were killed.

A collection of leafhoppers from the campus lawn, mostly E. inimica in various instars, were placed on seedling durum plants in the greenhouse and allowed to feed for 48 hours. The hoppers were removed from the durum plants which were then sprayed with a nicotine sulfate insecticide. No disease symptoms had developed in the durum plants 5 weeks after the test feeding period. The absence of symptoms indicated that the leafhoppers were not carrying the virus.

The virus-free leafhoppers were divided into two groups; half were placed on caged infected durum plants in the greenhouse and the other half on caged healthy durum plants to serve as checks. After an acquisition feeding period of 48 hours, each of the groups was divided into five subdivisions consisting of approximately 10 leafhoppers which were placed on durum plants for a test feeding period of 10 days. All plants were then sprayed with a nicotine sulfate insecticide. Two weeks following the test feeding some plants in each of the pots exposed to hoppers that had acquisition feeding on infected plants showed symptoms of the disease. None of the check plants showed symptoms 5 weeks after the test feeding period.

Several attempts to transfer the causal organism to other test plants from the infected plants failed. All these later attempts were with winged adult E. inimica.

Three species of aphids, the apple grain (Rhopalosiphum fitchii (Sand.)), English grain (Macrosiphum granarium (Kirby)), and the greenbug (Toxoptera graminum (Rond.)), were used in attempts to transfer the causal organism from durum to durum and barley. Acquisition feedings of 24, 48, and 72 hours and a test feeding of 48 hours were used with each species. No symptoms had developed in the plants 21 days after the test feeding.

Seed harvested from infected durum plants was planted in the greenhouse to see whether the disease was seed-borne. No symptoms had developed in the plants at the time of heading.

Bromegrass sod, supporting infected plants during the growing season, was transplanted to the greenhouse in October 1959. All plants were cut back to ground level and new growth was promoted by watering. During the winter the brome plants did not develop disease symptoms when subjected to various temperatures and light intensities.

Attempts to rear leafhoppers in the greenhouse were largely unsuccessful and only winged adult hoppers were used in attempting to transfer the causal organism.

DISCUSSION

The widespread occurrence of what presumably was striate mosaic throughout eastern North Dakota during 1959 can most easily be explained by assuming that heavy migrations of the leafhopper E. inimica carried the virus into the State from some area where the disease was prevalent. Another source may have been wild hosts such as bromegrass and an unusually heavy buildup of the vector. The disease had not been observed prior to 1959.

From the data obtained it would seem that the disease in durum in North Dakota is the same as the striate mosaic on wheat previously reported by Slykhuis (2). Recent papers by Sinha (1), Watson and Sinha (4), and Slykhuis and Watson (3) on European wheat striate mosaic indicate that the same disease occurs in England but that a different vector is involved. Transmission studies by these workers showed that adult leafhoppers were much less efficient in acquiring the virus than the young nymphs. Slykhuis (2), however, showed that there was little difference among instars of leafhoppers (E. inimica) in their efficiency as vectors of the virus in South Dakota.

In the work at North Dakota transmission of the virus was not accomplished when only winged adult leafhoppers were used as the vectors. Further work is necessary to determine the relative transmission efficiencies of the different leafhopper instars.

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PIC

SURVIVAL, COLONIZATION AND ANTAGONISM OF INDUCED MUTANTS OF CHAETOMIUM GLOBOSUM KUNZE[1]

T. H. Nicolson[2]

Summary

Induced mutants of Chaetomium globosum were studied with regard to survival in, and colonization of, oat straw segments in non-sterile soil. They differed in their abilities to survive in and colonize this substrate over varying periods as indicated by reisolation tests on nutrient media. None surpassed its parent in these capacities. Although most mutants of C. globosum reduced the pathogenicity of Helminthosporium victoriae and protected oats against its effects, only one mutant approached and sometimes exceeded the antagonism shown by the parental line. In general, mutants which showed best survival and colonization were also most active with regard to antagonism.

INTRODUCTION

Induced mutants of plant pathogenic fungi have been studied in natural environments (4). With mutants of non-pathogenic fungi most studies have been carried out under pure culture conditions. In the present investigations attempts were made to assess the natural survival and colonization abilities of induced mutants of the saprophytic species Chaetomium globosum Kunze on straw in non-sterile soil.

Certain species of the genus Chaetomium are antagonistic toward plant pathogenic fungi (5, 6). Consequently studies also were made to determine whether mutants of C. globosum were more or less antagonistic than the parental strain toward certain plant pathogenic fungi.

MATERIALS AND METHODS

The mutants used were isolated following treatment of ascospores with 5% uranium nitrate[3]. These differed distinctly in cultural characters chiefly in abundance and maturation of perithecia (Fig. 1).

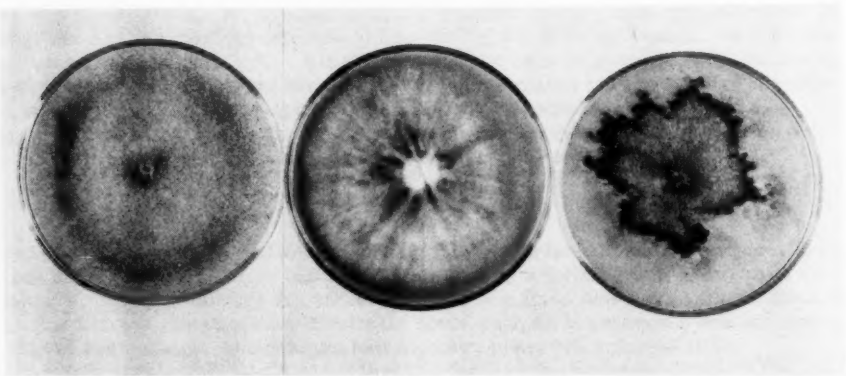

FIGURE 1. Three mutants of Chaetomium globosum induced by uranium nitrate. Left to right Mutant 39, 201 and 207.

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[2]Former Research Fellow, Department of Plant Pathology and Botany, University of Minnesota; now with the University of Nottingham School of Agriculture, Loughborough, Leicestershire, England.

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Survival and colonization abilities were tested by burying sterilized oat straw segments which had been inoculated with the parent and mutant strains of C. globosum. In survival tests inoculation of segments was followed by an incubation period in pure culture. When testing colonization two types of inoculum were used, macerated broth culture and agar discs, and the segments were inoculated immediately before burial. The aim here was to subject mutants to progressively more exacting conditions when competing with the soil microflora. The broth cultures were poured over the segments and the agar discs from growing colonies were placed in direct contact with segments before burial.

After different burial periods the segments were recovered from the soil, surface disinfected in sodium hypochlorite for 2 minutes, and plated on each of four culture media. These were rose bengal agar (3), acidified potato-dextrose agar, and two media which contained the basal mineral ingredients as given by Buston, Jabbar and Etheridge (1), plus macerated cellulosic materials or straw. Macerated filter paper or oat straw were used at the rate of 3 g per liter.

Two segments were placed on each Petri plate (Fig. 2) and duplicate plates were used for each medium and isolation series. The plates were incubated at 25° C, and examined at intervals for growth of the Chaetomium strains from the straw segments and the percentage isolations obtained.

FIGURE 2. Mutant 39 reisolated from oat straw segments which had been inoculated and then buried in non-sterile soil for 23 days.

The methods used to test mutant antagonism in soil corresponded closely to those used by Tveit and Moore (5). The antagonists tested were certain mutants and the parent strain. The pathogen used was Helminthosporium victoriae Meehan & Murphy, the causal organism of Victoria blight of oats, and the susceptible variety Vicland was used as the test host plant.

Tests were made in autoclaved 4-inch pots and autoclaved soil. In each pot 30 seeds were sown. One hundred ml of diluted broth culture (1/4 dilution) of both the antagonist and the pathogen were added simultaneously to the soil. Each treatment was made in triplicate. The greenhouse temperature was maintained at about 20° to 25° C. At germination and intervals thereafter to flowering records were made of the numbers of healthy and diseased seedlings.

RESULTS

Survival and Colonization: The results for testing survival and colonization are presented in Table 1. Survival was demonstrated in four out of seven mutants tested after a 30-day burial

Table 1. Survival and colonization of parent and mutant strains of Chaetomium globosum in oat straw segments buried in non sterile soil.

Strain	Survival: Percentage recovery after burial for: 30 days	38 days	51 days	72 days	Colonization: Percentage recovery after burial for: 16 days: dil.[c] broth	16 days: broth	23 days[b]: dil. broth	23 days[b]: broth	30 days[b]: agar disc
Parent	100	-[a]	92	96	50	38	81	56	33
Mutant No.				results obscured by soil fungi developing on plates					
2	4	0	-		0	0	0	0	0
6	0	0	-		0	0	0	0	0
23	0	0	-		0	0	0	0	0
39	17	17	33		25	6	50	38	4
197	26	0	-		0	0	19	6	0
201	0	0	-		0	0	0	0	0
207	12	33	21		19	6	62	3	0

[a]No tests made.
[b]Surface sterilization time of segments increased to 3 minutes in this series.
[c]Broth inoculum diluted 50%.

period but only two of these could be reisolated after 38- and 51-day intervals. Difficulty was experienced in these tests with the high prevalence of fast-growing soil moulds mainly Trichoderma and Mucor spp. The prevalence of the former was so great after a 72-day burial period that isolations on the mutant plates were completely obscured and subculturing was impossible. This did not affect material inoculated with the parent strain which remained active in segments through to the 72-day period.

In colonization tests where broth cultures were used as inoculum only two mutants were isolated after a 16-day burial period (Table 1). However, in the case of another mutant, 197, perithecia formed on the inoculated straws and these corresponded in appearance to those formed in pure cultures. After 23 days' burial, the surface sterilization time was extended from 2 to 3 minutes to cut down the numbers of contaminating organisms and facilitate reisolation of the mutants. With this treatment mutant 197 appeared on the plates and mutants 39, 207, and the parent strain were isolated a greater number of times. Hence, the isolation technique did not give a true assessment of colonizing ability. Although mutants may have colonized the straws in the soil they were at a disadvantage on agar plates when competing with fast-growing soil fungi.

As would be expected, the concentration of the broth inoculum affected colonization (Table 1). This was also true for the type of inoculum. When inoculum on agar disc was used, giving restricted contact with the substrate, colonization could be demonstrated for mutant 39 only.

Results for Antagonism: Three tests were made to assess the antagonism of various mutants against H. victoriae. In a preliminary test mutant 39 gave as much protection against the pathogen as the parental strain. In a second test with 12 mutants, 23, 39 and 197 gave more protection than the parent.

Table 2 presents in more detail data on four mutants which appeared to be most antagonistic in preliminary tests. Only mutant 39 was as effective against H. victoriae as the parental line. Although induced mutants in the various tests differed greatly in their abilities to inhibit the development of H. victoriae, most of them were less effective than their parent (Fig. 3). Only one mutant, 39, gave consistently good results.

Table 2. The antagonistic effect of four mutants and the parental line of Chaetomium globosum against Helminthosporium victoriae on oats when inoculated at time of planting.

Strain	Percentage germination of oats	Percentage of healthy plants at: 3 leaf stage	5-6 leaf stage	flowering
Parent	93[a]	87	80	70
Mutant No.				
23	87	70	57	53
39	90	80	73	70
197	90	57	40	30
207	87	60	43	40
Pathogen only	80	20	13	13
Control[b]	95	87	81	73

[a]The percentage figures were averages of three replicate pots with 30 seeds sown per pot.
[b]No organism added.

DISCUSSION

The reisolation of mutants from straw substrate evidently depended on the techniques used, as has been shown for isolation of root-disease fungi from dead host tissue (2). However, the results do indicate that survival and colonization of mutants did occur and varied considerably, but no mutant was as efficient as the parent strain in these respects. Hence, artificially-induced mutants can to some degree survive and compete, without change in identity, when subjected to agencies operating in a natural environment.

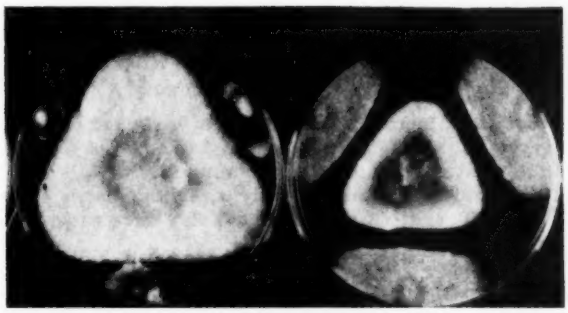

FIGURE 3. Two mutants of Chaetomium globosum that react differently against Helminthosporium victoriae.
(a) Colonies in center = H. victoriae.
(b) Colonies on periphery mutants of C. globosum (Left, mutant 2; right mutant 39).

Those mutants which showed best survival and colonization also were most active in inhibiting H. victoriae. This indicates that the effects obtained were due to active antagonism of the pathogen in the soil subsequent to inoculation, rather than to presence of antibiotic substances in the broth cultures.

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P1C

PHYSIOLOGIC RACES OF LEAF RUST OF WHEAT, PUCCINIA RECONDITA ROB. EX DESM. F. SP. TRITICI, IN THE UNITED STATES IN 1959[1]

C. O. Johnston[2]

Summary

Single-pustule isolations from 402 collections of leaf rust of wheat made in 33 States of the United States in the 1959 test season yielded 23 physiologic races. Physiologic race 15 was the most abundant and widely distributed, followed by races 2, 5, and 122 in order of decreasing abundance. Only these four races exceeded 3.0% prevalence. Races 1, 131, 69, and 143 were isolated only once each.

Collections of wheat leaf rust, Puccinia recondita Rob. ex Desm. f. sp. tritici, were received from many States in the United States during the fall of 1958, the winter and early spring of 1958-59, and the spring and early summer of 1959. Cultures were obtained from 402 collections representing 33 States. A total of 1447 single-pustule isolates from these revealed the presence of 23 physiologic races in the United States during the time covered. The results obtained from these analyses are shown in Table 1. The principal results may be briefly summarized as follows:

Despite isolation of 23 races, only four races, representing three unified race groups, were abundant. The races in order of abundance were 15, 2, 5, and 122. Those four races included 80% of all isolates.

Race 15 was present in greatest abundance and widest distribution. It comprised 50.6% of all isolates and appeared in isolations from collections made in all but two States. This is the third consecutive year race 15 was the leading race in the United States.

Race 2 was second in abundance, comprising 11.4% of all isolates.

Unified race-group 2, composed of the similar races 2 and 15, represented 62.0% of all isolates.

Race 5 was third in abundance, comprising 9.4% of the total number of isolates. It was present in each of the major wheat-growing areas but was not isolated from collections made at many of the stations.

Race 122 was fourth in prevalence, representing 8.6% of all isolates. It is the principal constituent of unified race-group 13. The other members of that group isolated from the collections were races 21, 54, 77, and 130. All members of that group together comprised 14.4% of all isolates.

Unified race-group 9, composed of the similar races 9, 13, 19, and 20, again proved to be unimportant except in the hard red winter wheat area where the group seems to be increasing.

Unified race-groups 6 and 10 were less prominent than in some earlier years.

Races 1, 131, 69, and 143 were isolated only once each.

Races 69, 130, 140, and 143 were races rarely encountered.

Only one culture was available for study from each of the following States: Indiana, Kentucky, Maryland, Pennsylvania, Louisiana, Colorado, and California. This is not considered enough to give an accurate picture of the physiologic race situation. Only two collections each from New York, West Virginia, South Dakota, and Idaho were available for analyses.

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[1]Contribution No. 569, Department of Botany and Plant Pathology, Kansas Agricultural Experiment Station, Manhattan, in cooperation with the Crops Research Division, Agricultural Research Service, United States Department of Agriculture. Botany serial No. 729.

[2]Plant Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

Table 1. Physiologic races of Puccinia recondita f. sp. tritici isolated from collections of leaf rust made on wheat in the United States during the crop year 1959 including the fall and winter of 1958 and early spring of 1959 as well as the main spring and summer crop.

Crop area and State	Number of isolates of unified races and constituent physiologic races																									Total number		
	1	2		3	5		6			9				10		13					14	17			Isolates	Races	Collections
	1	2	15	58	5	52	6	105	126	9	13	19	20	11	131	21	54	77	122	130	69	140	143			
Northeastern:																										
Arkansas		3	12	1	3	1	1			1		2	2				4		11					41	11	9
Illinois		2	20	1	10	1	2				1	1				1	3		12			2		56	12	9
Indiana							1										1		1	1	1			5	5	1
Kentucky			2	1		1																		4	3	1
Maryland		1	4																					5	2	1
Michigan		2	36	6	10		4	1					1	1			1		17	17				96	11	17
Missouri		3	18		10	2	1			1		7						1	6	6				55	10	11
New York		2	3					1					1	1			1							9	6	2
Ohio			3	7	1											1	6		6	4				28	7	5
Pennsylvania			1																					1	1	1
West Virginia		2	7																					9	2	2
Southeastern:																										
Alabama		36	50	2		2							2				3	12	14				1	122	9	51
Florida			26		6												1							33	3	8
Georgia		8	6														2	5						21	4	9
Louisiana			3	1																				4	2	1
Mississippi			29		5				1			3							10					48	5	13
N. Carolina		6	12	4	1			1		1		3					1		3					32	9	9
S. Carolina		1	74		10												1	1	11					98	6	26
Tennessee			8	1																				9	2	3
Virginia			15	2	5														2					24	4	5
North-Central:																										
Iowa		14	26		8	4		1			1		4				1	1	2					62	10	18
Minnesota		17	101	3	18	2		3	2	2		1	2				1		14					166	12	38
N. Dakota		6	40	1	4	2	1	2				2					1		3					62	10	19
S. Dakota			5																					5	1	2
Wisconsin		2	17		4	3	1			1		2	2	1			1	1	2					37	12	13
South-Central:																										
Colorado							1																	1	1	1
Kansas	1	46	170		19	3	1	1		15		4	12	2	1			2	4					281	14	80
Nebraska			5		4		1			3		1						1						15	6	4
Oklahoma			3											1										4	2	3
Texas		9	31		13	1	3	1	3	4		5	4	1			2	1	7			1		86	15	32
Wyoming		3	1		4	1				3		2	2											16	7	5
Western:																										
California			3		1																			4	2	1
Idaho		2	1									1	2	2										8	5	2
Total number	1	165	732	30	136	23	17	11	6	31	2	34	34	9	1	2	30	25	125	28	1	3	1	1447	23	402
Percentage of total isolates	.08	11.4	50.6	2.1	9.4	1.6	1.2	0.8	0.4	2.1	0.1	2.3	2.3	0.6	.08	0.1	2.1	1.7	8.6	1.9	.08	0.2	.08			

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, KANSAS STATE COLLEGE, MANHATTAN IN COOPERATION WITH CROPS RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

PIC

PHYSIOLOGIC RACES OF CROWN RUST OF OATS IDENTIFIED IN 1959[1]

M. D. Simons and L. J. Michel[2]

DESCRIPTIONS OF NEW RACES

Since compilation of previously unnumbered races of crown rust of oats (Puccinia coronata Cda. var. avenae Fraser & Led.) was made for 1958 (2), 21 new races have been discovered. Twenty of these, numbered 300 through 319, were isolated in Israel (3, 4). These races are of potential interest to North American plant breeders and pathologists because most of them attack the oat varieties Santa Fe and Bondvic, and over half parasitize Trispernia. Landhafer, in sharp contrast, is resistant to most of these races. A few attack both Landhafer and Santa Fe, but none resembles the North American race 298, which is characterized by virulence on Landhafer and avirulence on Santa Fe (2).

Race 320, isolated from material collected in New York by G. C. Kent, is a clear-cut race but is of little interest from the standpoint of practical plant breeding because most varieties now being used as sources of resistance are resistant to it.

PREVALENCE AND DISTRIBUTION OF RACES IN 1959

In 1959, as in the previous year, crown rust was rather light over the country as a whole. It was, however, scattered widely over the humid oat-growing States. Consequently, collections were received from Uniform Oat Rust Nurseries, other breeding and disease nurseries, and commercial fields representing most of the principal oat-growing regions of the United States. Six-hundred-eighty-five isolates from this material were identified (Table 1).

About half of the 1959 isolates identified were of race 216, making this race far more important than any other and continuing the pattern set in 1957 and 1958. Race 216 attacks the standard differential oat varieties Anthony, Victoria, Appler, Bond, and Ukraine. The remaining differentials and varieties derived from them are resistant under greenhouse conditions but under some field conditions may appear to be partially susceptible. All races of the Victoria race-group (mainly races 213 and 216) combined made up about 58% of the total as compared with about 70% in 1958. This difference may not be significant but is at least an indication that the rapid rise in prevalence of these races recorded in 1957 and 1958 has levelled off.

The second most common race was race 295. Like all other races of race group 290 (which includes races 290, 293, 294, 295, and 298), race 295 vigorously parasitizes Landhafer and Santa Fe but is innocuous on Trispernia and Bondvic. The races of race-group 290 combined accounted for about one-fourth of all isolates. Observations made in the field over the country by various people indicate that the actual prevalence of these races was considerably lower than this. Inadequate or improper sampling techniques may at least partially account for the discrepancy. Under roughly comparable systems of sampling, races of race-group 290 made up less than 10% of the total isolates in 1957 and 1958. Consequently, regardless of the absolute amount of these races, there is little doubt that they are becoming relatively more common.

Another trend involving a more subtle change concerns the relative prevalence of the individual biotypes comprising the races of race-group 290. When these races were first discovered, most biotypes induced highly resistant reactions in Victoria, Trispernia, and Bondvic, and commercial varieties of diverse genetic backgrounds were found to be resistant. In contrast, the biotypes observed in 1959 usually induced only moderately resistant reactions in these three differentials and severely attacked some of the commercial varieties that had been resistant to the earlier biotypes. From the practical standpoint, this shift might be regarded as a movement in the direction of race-group 264 (races 263, 264, and 276).

Race 264, which parasitizes all known sources of seedling resistance among the hexaploid oats, was a little more common than in 1958 but does not appear to be increasing as do races of race-group 290.

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[1]Cooperative investigations of the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and the Iowa Agricultural and Home Economics Experiment Station. Journal Paper No. J-3892 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1176. The authors acknowledge their indebtedness to the many investigators who supplied crown rust collections for identification.

[2]Pathologist and Agricultural Aid, respectively, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

Table 1. Numbers of isolates of races of P. coronata avenae obtained from oats grown in different regions of the United States in 1959.

Race	Region: North-central	North-eastern	South-central	South-eastern	% of total	Race	Region: North-central	North-eastern	South-central	South-eastern	% of total
201	1				.3	264	12	1	10	5	4.1
202	28	3	6	3	5.8	274	2		4	1	1.0
203	10	2	3		2.2	276			1		.1
205	3				.4	279	1				.1
209		7			1.0	280	1				.1
210		1			.1	281		1			.1
212	3	2			.7	282			1		.1
213	28	5	14	9	8.2	284	3	4			1.0
216	196	8	90	37	48.2	290	25	2	5	20	7.6
229		1			.1	293	1	2	2	2	1.0
235		1			.1	294	2		8	4	2.0
237	1				.1	295	52	3	21	17	13.5
238			1		.1	298	1				.1
240	2			1	.4	320		4			.6
258		1			.1						

The once-dominant Bond races, principally races 202 and 203, were less prevalent than at any time since the new standard set of ten differentials has been used.

Aecial collections from Rhamnus spp. received in 1959 were fewer than usual, and in many cases those received were not viable. A total of 39 isolates were identified from this material. Although the sample was small, the marked trend noted in 1958 toward relatively greater prevalence of Bond races in proportion to Victoria races when compared with the isolates from oats was still evident. This relationship, more fully discussed earlier (2), appears to be due to the paucity of telia produced by the Victoria races.

REACTIONS OF SUPPLEMENTARY DIFFERENTIAL OAT VARIETIES

Most of the crown rust collections received in 1959 were used for testing the reactions of eight supplementary differential varieties. Some of these varieties served to establish that a number of the isolates which appeared homogeneous on the standard differentials were actually composed of two or more different biotypes. Conversely, a number of isolates omitted from Table 1 because they contained unidentifiable mixtures of races or biotypes appeared uniform on one or more supplementary differentials. A detailed discussion of the methods and objectives of testing supplementary crown rust differentials was presented earlier (1).

The diploid C.I. 3815 was highly resistant to all isolates, and the tetraploid C.I. 7233 was resistant or moderately resistant to all isolates. The latter strain showed better resistance to the Landhafer races than it did to the Victoria races. The diploids C.I. 4747 and C.I. 2630 (Glabrota) were highly resistant to most isolates but were susceptible to some, including an occasional biotype of one of the races of race-group 290.

Both Ascencao and P.I. 174513 show a moderately resistant to intermediate "Victoria-type" reaction to race 264. Except for being susceptible to very rare biotypes of common races, Ascencao is virtually immune from all other races, including race-group 290. P.I. 174513 is resistant to common races but is susceptible to race-group 290. These reactions are useful in distinguishing races of race-group 264 from the more aggressive biotypes of race-group 290 mentioned before.

Ceirch Dubach is very unsatisfactory as a differential, but it does appear to have at least some degree of resistance to all Landhafer races (race-groups 264 and 290) under some conditions. It apparently is susceptible to all races that attack Saia and to occasional biotypes of other races. C.I. 4727 is a strain of Avena sterilis that was once thought to be resistant to race-group 290. In 1959, however, a majority of the isolates of this race-group attacked C.I. 4727.

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P16

ROOT ROT OF WHITE OAK IN ARKANSAS

E. Richard Toole[1]

In June 1959 dead and dying white oaks (Quercus alba) were observed at several locations in the Ozark Mountains of Arkansas. Examinations of the roots of these trees revealed a whitish to light buff crustose layer of Corticium-like fungus material at or near the rootcollar 1 to 6 inches below the ground line (Fig. 1). Cultures were identified as Corticium galactinum (Fr.) Burt by Ross W. Davidson of the Forest Disease Laboratory at Beltsville, Maryland.

FIGURE 1. Corticium galactinum sporophores below ground line on a white oak.

The affected trees were growing singly or in groups of two or three. In some groups a gradual tree-to-tree spread was evidenced by the fact that some trees had been dead for several years, while others that were alive but unthrifty had C. galactinum on their roots. The diseased trees varied from 2 to 10 inches in diameter at breast height (4 1/2 feet above ground line). Most were on sites regarded as poor for white oak.

Informal surveys in 1959 and 1960 showed that C. galactinum is present on white oaks in Carroll, Madison, Newton, Boone, Johnson, Fulton, and Pope counties. It probably also occurs in other areas of northern Arkansas.

No previous records are known of the association of this fungus with root rot of Quercus alba. Von Schrenk and Spaulding (3) reported it in 1909 (under the name Thelephora galactina Fr.) on black oak and some other Quercus species in the Ozarks. It is a pathogen of apple trees and a number of ornamentals (1, 2).

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[1]Plant Pathologist, Southern Forest Experiment Station, Forest Service, United States Department of Agriculture; assigned to the Stoneville Research Center, maintained at Stoneville, Mississippi, in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.

PIC

DECAY 5 YEARS AFTER THINNING OF SWEETGUM SPROUT CLUMPS

E. Richard Toole[1]

Abstract

The clumps -- about 55 years old -- had originated near the ground line, and thinning the surplus stems caused no rot in those reserved for growth. Stubs of cut stems decayed at a rate that was linearly related to their diameter and to the length to which they had split during logging.

When sweetgum (Liquidambar styraciflua) stands of sprout origin are thinned for pulpwood, it is common practice to reduce clumps to a single stem. The present study was undertaken to determine whether the stubs created by cutting form a decay hazard to the remaining stem.

No similar investigations have been reported for bottom-land hardwoods of the South, but Roth and Hepting (3) evaluated the incidence of butt rot in sprout oak stands of the Appalachians. They found that 20% of the trees had become infected through wounds or stubs left from a thinning made 6 to 12 years previously. Wounds larger than 4 inches in diameter remained open for at least 5 years. Roth (1), observing oak sprout stands 16 years after thinning, noted that decay hazard rose rapidly when the sprouts removed were more than 3 inches in diameter at breast height (4 1/2 feet above ground). Roth and Hepting (2) reported that oak sprouts of low origin have the least decay hazard. Earlier, Roth and Sleeth (4) had demonstrated that decay organisms may spread from the parent stump into oak sprouts.

METHODS

The study was in a sweetgum sprout stand on Mississippi River bottom lands near Tallulah, Louisiana. The owner of the 46-acre tract, the Chicago Mill and Lumber Company, thinned for pulpwood in the early spring of 1955. Before the thinning, the stand had 209 stems per acre, a basal area of 117 square feet, and a volume of 3028 cubic feet. Average age of the trees was 55 years.

In April 1955, 189 clumps that had been thinned to one stem were selected for periodic observation. This sample included 197 cut stems. Average height of the crotch above ground was 45 inches, and the height of the stub above the crotch ranged from 0 to 21 inches. The stubs were examined yearly to determine deterioration, number and size of sprouts, and fungus fruiting bodies. Five years after the thinning, 12 trees with stubs or wounds were cut and dissected.

RESULTS

Extent of rot was determined by measuring the distance that a machete blade penetrated easily. In the first year or two after the thinning all stubs had sound surfaces, but later most showed considerable rot. As the loggers made no undercuts, some of the bark and wood of most stubs split off when the stems fell. The distance that the rot had spread down from the stub top was found to be linearly related to the diameter of the stub and the length of the split. The height of the crotch above ground and the length of the stub had no significant effect on length of rot.

The final regression equation used in developing the predictions of downward spread of rot was:

$$Y = 4.008 + .415\,x_1 + .141\,x_2$$

Y = downward extent of rot (in inches) in stubs 3 years after cutting

x_1 = top diameter of stub in inches

x_2 = length (in inches) that the stub is split down from the top

The mean squared residual for this equation is 35 on 184 degrees of freedom and the coefficient of multiple correlation, .614, is significant at the 1% level. These relationships are represented graphically in Figure 1. Table 1 gives average extent of rot 3, 4, and 5 years after thinning.

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[1]Plant Pathologist, Southern Forest Experiment Station, Forest Service, United States Department of Agriculture; assigned to the Stoneville Research Center, maintained at Stoneville, Mississippi, in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.

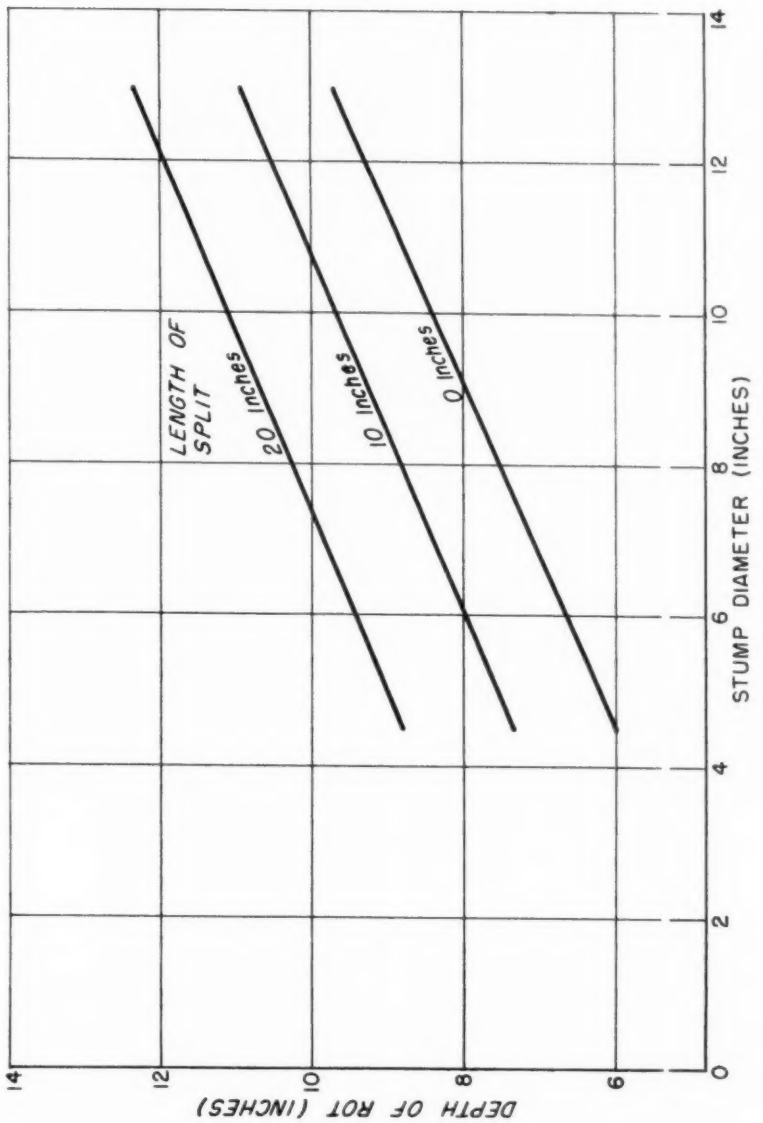

FIGURE 1. Rot in 3-year-old stubs of sweetgum sprout clumps. Diameter of the stub and length to which it had been split chiefly determined the rate at which rot moved downward from the stub top.

Table 1. Downward extent of rot in sweetgum stubs created by thinning of sprout clumps early in 1955.

Stump diameter (inches)	Average extent of rot (with standard error) (inches)		
	Jan. 1958	Jan. 1959	Jan. 1960
6	6.9 ± .8	18.9 ± 1.8	20.6 ± 1.7
8	8.8 ± .6	19.3 ± .9	20.9 ± .9
10	8.5 ± 1.1	19.8 ± 1.6	22.2 ± 1.4
12	10.3 ± .9	24.3 ± 3.4	26.6 ± 1.0

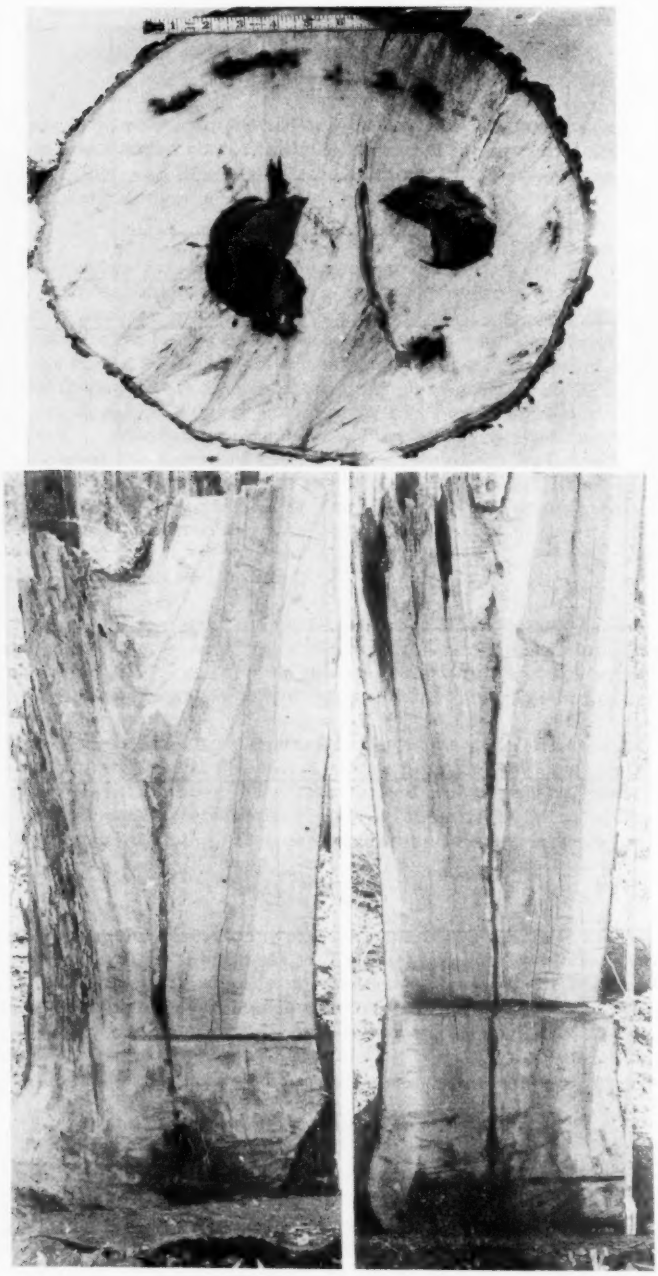

FIGURE 2. Above -- Section through twin sprout clump, showing thickness and length of bark barrier. Below -- One stem was cut from each of these clumps 5 years ago. In stub at left, rot has progressed nearly to ground line; in the other it is restricted to the upper part.

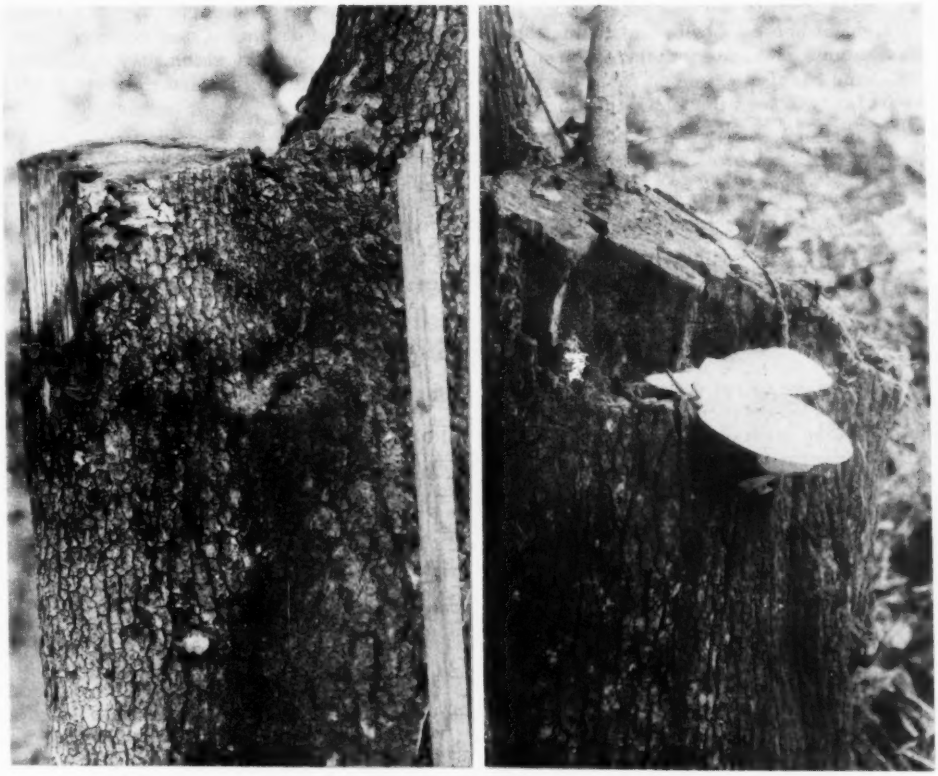

FIGURE 3. Left -- Daedalea confragosa fruiting on a 1-year-old stub.
Right -- Pleurotus ostreatus on a 5-year-old stub.

Table 2. Fungi fruiting on stubs resulting from the thinning of sweetgum sprout clumps.

Fungus	% of stubs with conks				
	1956	1957	1958	1959	1960
Daedalea confragosa (Bolt.) Fr.	2	27	39	2	3
Laxitextum bicolor (Pers.) (Fr.) Lentz	0	5	1	0	0
Schizophyllum commune Fr.	0	0	3	0	0
Panus sp.	0	0	3	0	0
Polyporus adustus (Willd.) Fr.	0	0	0	1	0
P. gilvus Schw.	0	0	1	0	0
P. versicolor (L.) Fr.	0	0	1	5	2
Hydnum septentrionale Fr.	0	0	1	0	0
Pleurotus ostreatus (Jacq.) Fr.	0	0	0	0	4

Dissection of the 12 trees showed that after 5 years no rot had entered the live stem. All these sprouts had originated 1 to 5 inches below the present ground line. In several clumps small bits of charred wood were found near the point of origin -- an indication that the trees developed from root sprouts after a fire had killed the above-ground parts of young sweetgum.

Height of crotch was not an indication of height of sprout origin. Companion sprouts united into a common stem for a distance of several feet above the point at which they originated. A partial bark barrier extended from the point of origin of all clumps toward the crotch (Fig. 2). The barrier was less than 1/2-inch thick, but varied in width from 2 to 8 inches.

The succession of fungi, as evidenced from sporophores, is indicated in Table 2. Fungi were most prevalent 3 years after cutting, at which time 49% of the stubs had conks. All fungi found in the first 4 years after cutting are generally considered to be primarily sapwood rotters. Of these, Daedalea confragosa (Fig. 3, left) was most common. After 5 years, Pleurotus ostreatus (Fig. 3, right), an important heartwood and sapwood rotter, was found on 4% of the stubs.

Three years after cutting, 60% of the stubs had sprouts that averaged 5 feet in length. Some sprouts lived only a few years.

DISCUSSION

The increase of rot with increase in stub diameter and bark splitting is in agreement with other work. The absence of rot in the main stems can be accounted for by the low origin of the sprouts. Other studies are needed to evaluate the effect of height of sprouting on rot hazard.

It is apparent that in sweetgum clumps from root sprouts, such as those studied here, there is little rot hazard to the remaining stem 5 years after cutting, regardless of the size of the stems removed. Longer observations will be required to determine how size of stub and wound influences ultimate rot hazard.

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ACTION OF ODORIFEROUS ORGANIC CHEMICALS AND ESSENTIAL OILS ON WOOD-DESTROYING FUNGI[1]

Jasper C. Maruzzella[2], Denis A. Scrandis, Joseph B. Scrandis, and George Grabon

Abstract

One hundred and ninety-three aromatic agents consisting of 115 essential oils and 78 organic chemicals were screened in vitro against three wood-destroying fungi using the filter paper disk method. Seventy-two % of the essential oils and 73% of the organic chemicals produced zones of inhibition against at least one of the three test organisms. Prominent zones of inhibition were produced with oil of garlic (imported), origanum (rectified water white), thyme red, cassia, and styrax; and by hydratropic aldehyde, iso-valeric acid, n-caproic acid, cinnamic aldehyde, and eugenol. It is suggested that some of the aromatic agents screened might be of value in the wood preserving industry.

INTRODUCTION

Recent in vitro studies have indicated that some essential oils might be used successfully in the control of certain phytopathogenic fungi (2, 3). In this study the action of essential oils as well as odoriferous organic chemicals have been tested against three species of wood-destroying fungi of economic importance in the wood-preserving industry. This report deals with the initial screening data using the filter paper disk method.

MATERIALS AND METHODS

The test organisms used were Lenzites trabea ATCC 8715, Polyporus versicolor ATCC 11235, and Lentinus lepideus ATCC 11453. These organisms were maintained on Sabauraud's maltose broth and subcultured every 2 weeks. The method of Vincent and Vincent (6) was employed for detecting the presence or absence of antifungal activity. In this filter paper disk method sterile disks (6.35 mm diameter) were thoroughly saturated with the oil or chemical to be tested. The saturated disks were then placed on the surface of Sabauraud's maltose agar plates which had been previously seeded with 1 ml of fungal broth culture. All dishes were conducted in triplicate with one disk per dish and incubated for 12 to 14 days at room temperature. The presence of zones of inhibition surrounding the saturated paper disks indicated antifungal activity and the zones were recorded in millimeters with a metric ruler with the aid of an illuminated Quebec colony counter.

RESULTS AND DISCUSSION

Table 1 lists 115 essential oils and their zones of inhibition against each test organism. Eighty-three oils (72%) were found to possess some activity against at least one of the test organisms. Prominent zones of inhibition were produced by the following oils against all test organisms: garlic imported, origanum rectified water white, thyme red, cassia, styrax, coriander, bay, peppermint natural, chenopodium, and Bois de Rose Peruvian. In the previous work reported in this journal (2) these essential oils were also found to markedly inhibit many phytopathogenic fungi but the zones of inhibition were much larger than found in this study.

Table 2 lists the 78 odoriferous organic chemicals (2 acetals, 3 acids, 12 alcohols, 9 aldehydes, 40 esters, 2 ethers, 7 ketones, 1 lactone and 2 miscellaneous) and their zones of inhibition against each test organism. Fifty-seven chemicals (73%) produced zones of inhibition with at least one of the three test organisms. These data also reveal that the chemicals were active against the fungi in the following order of decreasing activity: miscellaneous, acids, aldehydes, alcohols, lactone, acetals, ketones, ethers, and esters. The chemicals with the largest zones of inhibition against all test organisms were: hydratropic aldehyde, iso-valeric

[1]The authors wish to thank Magnus, Mabee, and Reynard, Inc., New York and Fritzsche Brothers, Inc., New York for the essential oils and the Trubek Laboratories, Inc., New Jersey for the organic chemicals used in this investigation.

[2]Associate Professor of Biology and undergraduate students, Department of Biology, Long Island University, Brooklyn, New York.

Table 1. Inhibitory activity of essential oils[a].

Oils	L. trabea	P. versicolor	L. lepideus
Abies alba, from cones	0	0	0
Abies alba, from needles	0	0	0
Abies sibirica	3	0	5
Allspice, NF	20	8	10
Amber, rectified	0	0	0
Angelica seed	5	2	0
Anise, USP	12	5	18
Balsam, Peru	6	0	0
Basil, sweet	10	10	0
Bay, NF	15	10	26
Bay laurel leaves, distilled	5	0	2
Bergamot, NF	3	0	0
Birch tar, rectified	11	7	2
Bois de Rose, Brazilian	16	13	3
Bois de Rose, Peruvian	9	20	15
Cade, rectified, USP	5	2	3
Cajaput	1	2	5
Calamus	6	4	1
Camphor, sassafrassy	9	2	5
Camphor, white	0	0	0
Cananga, rectified	0	0	0
Caraway, NF	0	0	0
Cassia, USP	31	24	15
Cedar leaf	2	0	0
Cedar wood	0	0	0
Celery seed	0	8	4
Chamomile, English	5	0	0
Chamomile, Roman	5	0	0
Chenopodium, NF	15	16	18
Cinnamon bark, Ceylon	15	15	10
Cinnamon leaf, Ceylon	15	0	25
Citronella, Ceylon	15	5	10
Clove, USP	20	6	15
Clove leaf, Madagascar, redistilled	20	10	10
Clove leaf, rectified	20	6	15
Clove stem, Zanzibar, redistilled	20	4	13
Cognac, green	0	0	0
Copaiba	0	0	0
Coriander, USP	20	20	12
Cubeb	0	0	0
Curacao peel	3	0	0
Cypress	0	0	0
Dill seed	7	0	0
Dill weed	6	5	4
Erigeron, American, USP	0	0	0
Estragon	3	0	0
Eucalyptus, NF, rectified	4	0	5
Eucalyptus, NF, 80/85%, redistilled	0	0	0
Eucalyptus, NF, 70/75%, redistilled	0	0	0
Eucalyptus, NF, 80/85%, single distilled	15	0	0
Eucalyptus, NF, 70/75%, single distilled	0	0	3
Fennel, USP	18	11	4
Fir needle, Canadian	2	0	0
Galbanum	2	0	0
Garlic, imported	25	30	50
Ginger	0	0	0
Gingergrass, native	5	2	7
Grapefruit, expressed, Florida	0	0	0
Hemlock	2	0	0
Labdanum	3	4	0
Lavandin	0	8	0
Lavender, USP	3	4	3
Lavender spike	15	5	3
Lavender spike, acetylated	0	0	2
Lemon, California cold pressed, USP	0	0	0
Lemon, Italian hand pressed, USP	2	0	25
Lime, expressed	3	2	0
Lime, distilled	2	0	0
Linaloe Wood	0	0	0
Lovage	3	2	4
Mandarin, Italian	2	0	3
Majoram, sweet	11	11	6
Mountain laurel	11	5	4
Nutmeg, East Indian, USP	11	7	10
Ocotea cymbarum	14	4	4
Olibanum	2	0	0
Opopanax	2	0	0
Orange, bitter	0	0	0
Orange, sweet, California cold pressed, USP	0	0	0
Origanum, rectified, water white	35	8	50
Palmarosa	15	7	7
Patchouly	0	0	0
Patchouly, Singapore	1	1	0
Pennyroyal, imported	17	5	8
Pepper, black	0	0	0
Peppermint, rectified, USP	24	10	5
Peppermint, natural	14	20	17
Persic, USP	0	0	0
Petitgrain, Paraguay	7	10	3
Pimenta from berries	18	5	11
Pimenta leaf	23	5	12
Pinus pumilio	0	0	0
Pinus sylvestris	0	0	0
Rosemary, NF	0	0	0
Rosemary, acetylated	2	0	0
Rosewood	4	8	12
Rusci, rectified	10	6	0
Sage Clary	10	2	2
Sandalwood	0	0	0
Sandalwood, West Indian	2	2	0
Savin	5	0	0
Snakeroot, Canada	5	6	4
Spearmint, NF	5	2	5
Spruce	0	0	0
Styrax	15	21	18
Sweet birch, Northern, USP	0	8	2
Tangerine	0	0	0
Tansy	0	0	0
Tar, rectified, NF	11	16	8
Thyme, red, NF	40	25	15
Ti-Tree, Australian	3	0	0
Turpentine, rectified, NF	0	0	0
Vetiver, Haiti	0	0	0
Wormwood	2	0	0
Ylang Ylang	4	2	0

[a]Zones of inhibition in mm, measured from disk edge to zone edge.

Table 2. Inhibitory activity of organic chemicals[a].

Chemicals	L. trabea	P. versicolor	L. lepideus
ACETALS:			
Hydratropic aldehyde dimethyl acetal	9	3	2
Phenyl acetaldehyde dimethyl acetal	15	5	2
ACIDS:			
n-Caproic acid	25	19	25
Heptoic acid	28	8	15
iso-Valeric acid	35	15	25
ALCOHOLS:			
Benzyl alcohol	2	3	0
Citronellol	12	9	4
1-Decanol	7	2	8
Dimethyl benzyl carbinol	7	11	8
3,7-Dimethyl-1-octanol	7	5	4
Gernaiol	20	6	6
1-Heptanol	0	13	5
1-Hexanol	4	0	0
Linalool	3	9	2
1-Nonanol	2	6	7
Phenyl propyl alcohol	15	12	12
Sterolyl alochol	6	8	0
ALDEHYDES:			
Aldehyde C-18	9	6	8
Aubepine	11	12	7
Cinnamic aldehyde	19	25	20
Cyclamen aldehyde	25	7	15
Hydratropic aldehyde	50	35	25
alpha-Methyl cinnamic aldehyde	20	10	10
Phenyl Acetaldehyde	8	20	3
Phenyl propylaldehyde	10	22	12
Undecyl aldehyde	0	0	5
ESTERS:			
Allyl caproate	2	0	7
Allyl heptoate	0	0	0
iso-Amyl n-butyrate	0	0	0
iso-Amyl propionate	0	0	0
Benzyl acetate	0	5	3
Benzyl formate	3	0	2
Benzyl propionate	14	6	2
iso-Butyl formate	0	0	0
iso-Butyl benzoate	15	5	3
n-Butyl n-butyrate	0	0	0
iso-Butyl n-butyrate	0	0	0
n-Butyl propionate	0	0	0
n-Butyl iso-valerate	0	0	4
iso-Butyl iso-valerate	0	0	0
Cinnamyl formate	8	8	10
para-Cresyl acetate	23	14	20
Diethyl succinate	0	2	0
Ethyl benzoate	7	14	9
Ethyl n-butyrate	0	0	0
Ethyl caprylate	3	0	5
Ethyl cinnamate	3	6	2
Ethyl heptoate	3	0	0
Ethyl propionate	0	0	0
Ethyl iso-valerate	0	0	0
Heptyl acetate	0	0	4
Heptyl formate	0	0	0
Hexyl acetate	0	0	0
Linalyl cinnamate	0	0	0
Linalyl formate	3	0	0
Linalyl propionate	0	0	0
Methyl cinnamate	7	6	3
Methyl phenyl acetate	2	10	0
Methyl phenyl carbinyl acetate	25	8	5
Octyl acetate	0	0	0
Octyl formate	0	0	2
Phenyl ethyl iso-butyrate	6	10	2
Phenyl ethyl formate	15	6	10
Phenyl ethyl propionate	4	7	0
Phenyl propyl acetate	3	6	3
n-Propyl propionate	0	0	0
ETHERS:			
para-Cresyl methyl ether	0	0	0
iso-Safrol	27	4	0
KETONES:			
Acetophenone	0	0	0
Acetyl valeryl	0	0	0
Di-n-propyl ketone	0	0	0
para-Methoxy acetophenone	10	10	8
para-Methyl acetophenone	18	15	18
Methyl heptenone	0	2	0
Methyl nonyl ketone	0	2	3
LACTONES:			
gamma Decalactone	7	5	7
MISCELLANEOUS:			
Eugenol	27	10	25
iso Eugenol	20	10	10

[a]Zones of inhibition in mm, measured from disk edge to zone edge.

acid, n-caproic acid, cinnamic aldehyde, eugenol, para-cresyl acetate, heptoic acid, para-methoxy acetophenone, cyclamen aldehyde, and phenyl propyl aldehyde. Further inspection of the data in Tables 1 and 2 shows that L. trabea was more sensitive than P. versicolor and L. lepideus to all aromatic agents tested.

Studies on the antimicrobial properties of odoriferous organic chemicals have been limited to human pathogenic bacteria and yeasts (1, 5, 4).

The findings presented seem to indicate that certain essential oils and organic chemicals might be used successfully in the control of wood-destroying fungi. It is important to note that in this study the oils and chemicals were used at full strength against the fungi. Whether these aromatic agents can retain their lethal action against the microbes at lower concentrations is an area that is being explored at the present time in this laboratory.

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P1C

EFFECTS OF SOIL TEMPERATURE ON THE PATHOGENICITY OF RHIZOCTONIA SOLANI ISOLATES[1]

R. E. Hunter[2], E. E. Staffeldt[3] and Charles R. Maier[4]

Summary

Three isolates of Rhizoctonia solani, which had been rated in preliminary tests as mildly, moderately, or highly pathogenic, were tested for pathogenicity to Acala cotton seedlings at four temperatures (20°, 24°, 27.5° and 32° C). The pathogenicity of the isolates varied with soil temperatures and each isolate produced a different pattern of virulence.

Richards (5, 6) was one of the first investigators to call attention to the effect of soil temperatures on the infectivity of Rhizoctonia solani (Corticium vagum) as related to diseases of pea, bean, potato and cotton. He pointed out that the optimum temperature for disease development (18° C) was similar to the optimum required for the saprophytic activity of the fungus. Vasudeva and Ashraf (10) concluded that cotton infected by R. solani suffered most damage at soil temperatures of 35° to 39° C and that disease severity decreased as soil temperatures decreased. Walker (11) reported that 17° to 23° was the optimum range for killing of cotton plants by R. solani. Arndt (1) stated that this fungus was most destructive on cotton at 21°. Other optima for infection of various crops by R. solani have been reported in several papers which have been reviewed by Kernkamp et al. (2).

Sanford (7) found that different isolates of R. solani varied in their virulence and rate of growth at different temperatures. Ortega (4) obtained similar evidence on the relationship of soil temperature to the pathogenicity of six isolates of R. solani on vegetable crops. Khan (3) studying three isolates of R. solani on several legume crops obtained excellent evidence in support of the above conclusions. Schwegmann (8) working with one isolate of R. solani found that it caused severe damping-off of cotton only under 18° C. By screening a number of isolates, he found several which caused severe injury when temperatures were kept above 25°.

The present study was initiated to determine the effect of soil temperatures on the disease incidence in cotton for three isolates of R. solani which distinctly differed in pathogenicity. Preliminary reports by Staffeldt and Maier (9) disclosed 10 distinct "strain" reactions of 245 isolates from agricultural areas of New Mexico. The current study utilized this pathogenic variation in selecting test isolates.

MATERIALS AND TECHNIQUES

The effect of varied soil temperatures on the pathogenicity of selected R. solani isolates was studied in the greenhouse, using three isolates which had been rated as mildly, moderately, and highly pathogenic, with a non-inoculated check. The temperature tanks were used at two temperatures, each tank holding 16 soil cans. The four temperatures used, 20°, 24°, 27.5° and 32° C, necessitated repeating the experiment at different temperature settings for one complete trial. Four trials were conducted over a 10-month period.

Both cans and soil, a screened soil-sand mixture, were steam sterilized. Four cans were seeded with each isolate, and the remaining four cans left as a non-inoculated check. Sclerotial suspensions in water were added to each can, and the cans placed in the tanks and incubated for 3 days. Acid-delinted, untreated Acala seed was planted, using 10 germinable seeds per can. Eleven days elapsed after planting each test before the seedlings were dug and graded according to the severity of Rhizoctonia infection. A disease index was calculated for the seed-

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lings in each can: an index of 0 meant all seedlings free of infection, and an index of 100 meant all seedlings dead, or a combination of dead seedlings and rotted seed.

EXPERIMENTAL RESULTS

Disease indices were obtained for all isolates at each of the four temperatures; the mean indices for all trials are given in Table 1 and graphed in Figure 1. Differences between means of isolates for all temperatures were significant at the 1% level. Differences between the means of temperatures for all isolates were not significant. However, different soil temperatures affected the pathogenicity of the isolates differently. The optimum temperature over the range studied for infection by the mildly pathogenic isolate (A) was 24° C, that for the moderately pathogenic isolate (B) was 32°, while the amount of infection resulting from the highly pathogenic isolate (C) was relatively constant at 24°, 27.5° and 32°.

Table 1. Pathogenicity of three Rhizoctonia solani isolates on Acala cotton at four temperatures expressed as the means of disease indices for four replications.

Isolate	Temperatures (°C) and disease indices: 20	24	27.5	32	Mean	Pathogenicity rating
A	23.0	31.8	13.0	21.0	25.4	mild
B	59.5	72.1	70.7	80.0	71.1	moderate
C	58.5	88.2	90.2	88.0	83.5	severe
Check	32.5	18.3	8.5	12.7	18.1	------
Mean	43.4	52.6	45.6	50.4		
LSD .05					7.8	
.01					10.4	

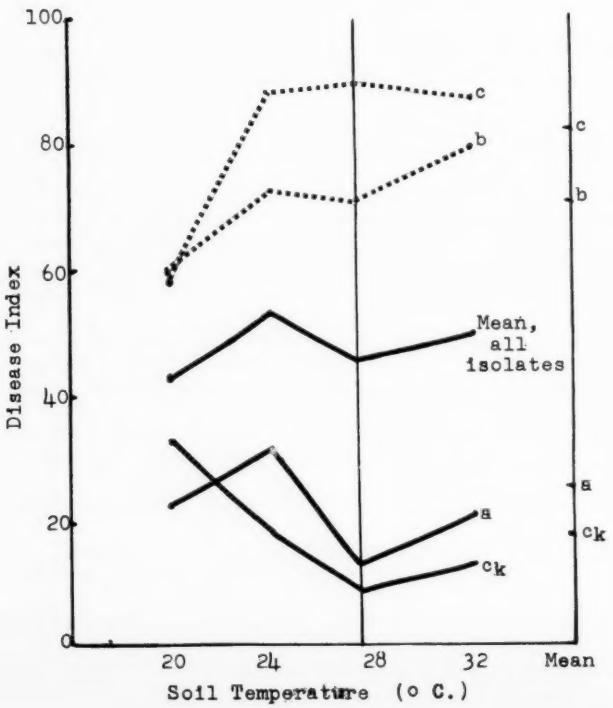

FIGURE 1. Pathogenicity of three Rhizoctonia solani isolates to Acala cotton at four temperatures, expressed as the means of disease indices for four replications. Means at right are for each isolate at all soil temperatures.

DISCUSSION

The pathogenicity of the three isolates of R. solani varied with soil temperatures and each isolate produced a different pattern of virulence over the temperature range studied. When the patterns of virulence of the isolates studied herein are compared with the patterns of virulence of isolates studied by other investigators (1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11) it appears that establishment of host-parasite interactions take place over a wide range of soil temperatures. Therefore, in many soils, strains of R. solani are probably present which could cause severe injury to cotton within the minimum, optimum and maximum temperatures of host-plant growth.

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P/C

RAPID DEGENERATION OF SOME STRAWBERRY VARIETIES AND SELECTED SEEDLINGS INFECTED WITH LATENT C VIRUS IN COMBINATION WITH OTHER VIRUSES[1]

P. W. Miller[2]

In 1956 McGrew (2) announced the discovery of a new strawberry virus which he named "latent C." It was found in commercial stocks of Big Joe, Dorsett, Suwannee, and Kellog's Premier strawberry varieties. This virus is latent in some clones of Fragaria vesca and will not produce symptoms in them even though the latent A virus is introduced, but other clones show symptoms even though latent A is not present (3). By inoculation experiments with this virus component, McGrew and Scott (4) discovered that latent C caused a marked reduction in plant vigor and in yield of the Catskill and a slight reduction in vigor and fruit size, but not in yield, of Blakemore.

Studies with this virus in Oregon were initiated by the writer in 1959 in connection with virus tolerance tests of named varieties and seedlings selected for the U. S. Department of Agriculture strawberry breeding project.

METHODS AND MATERIALS

Plants of varieties and selections evaluated were grown in the greenhouse until at least four mature or semi-mature leaves were present. Three plants of each variety or selection were then inoculated with latent C virus[3] in combination with other known viruses by using Miller's modification of Bringhurst and Voth's excised leaf-petiole graft technique (5). The viruses were introduced singly and/or in combinations of two or more; the inoculum consisted of two excised leaf-grafts of each virus. The inoculated plants were then placed in a moist chamber for about 10 days, after which they were held in the greenhouse at 65° to 70° F. Most of the inoculated plants were indexed later to determine whether they had become infected with the viruses in the inoculum. Uninoculated potted plants of the same variety or clonal seedling were maintained for comparison.

FIGURE 1. U. S.-Ore. selection 2707 naturally infected with a yellows virus complex; note absence of virus symptoms.

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[2]Plant Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

[3]The latent C virus was obtained from J. R. McGrew who "isolated" it from the Premier variety; it is held in Frazier's UC-1 clone of F. vesca which is a symptomless carrier of latent C virus.

RESULTS

Table 1 records the results of some typical experiments. In most varieties and selections the latent C virus, when added to other viruses, caused more rapid and severe plant degeneration than any of the viruses singly or in combination. In some cases, noticeable virus symptoms appeared within 29 days. Severe degeneration, characterized mainly by extreme stunting, curling and twisting of the leaves, was generally evident in 4 to 12 weeks (Figs. 2 and 4). Many varieties and selected seedlings tolerant to yellows virus complex such as mild yellow-edge + crinkle + latent A became severely stunted in a relatively short time when the latent C virus was added (Figs. 1 to 4, inclusive). No other virus component when present as a complex has

FIGURE 2. Severe dwarfing of U. S.-Ore. 2707 strawberry infected with latent C + yellows virus complex (the yellows complex was originally in clone when collected from field). Photographed 64 days after latent C was added.

FIGURE 3. Northwest (clone 10) infected with mild yellow-edge + veinbanding + mottle + crinkle + latent A; inoculated by excised leaf-grafts. Note absence of virus symptoms; photographed 169 days after inoculation.

Table 1. Development and severity of virus symptoms caused by latent C and other viruses in strawberry varieties and selected seedlings.

Virus and/or virus complex, and variety or selection inoculated	Results of reindexing[a]	Relative severity of symptoms[b]	Incubation period (days)
Latent A			
U. S.-Ore. 2331	+	none	--
Latent A + latent C			
U. S.-Ore. 2331	+	moderate	90
Yellows complex			
U. S.-Ore. 2707	+	none	--
Yellows complex + latent C			
U. S.-Ore. 2707	+	severe	39
Yellows complex			
U. S.-Ore. 2328	+	none	--
Yellows complex + latent C			
U. S.-Ore. 2328	+	moderate	75
Yellows complex			
U. S.-Ore. 2727	+	none	--
Yellows complex + latent C			
U. S.-Ore. 2727	+	moderate	24
Yellows complex			
U. S.-Ore. 2578	+	none	--
Yellows complex + latent C			
U. S.-Ore. 2578	+	moderate	55
Yellows complex			
U. S.-Ore. 2575	+	none	--
Yellows complex + latent C			
U. S.-Ore. 2575	+	moderate	62
Mild yellow-edge + crinkle + latent A + mottle + veinbanding			
U. S.-Ore. 2234	+	none	--
Mild yellow-edge + crinkle + latent A + mottle + veinbanding + latent C			
U. S.-Ore. 2234	+	severe	85
Mild yellow-edge + crinkle + latent A + mottle + veinbanding			
U. S.-Ore. 2331	+	none	--
Mild yellow-edge + crinkle + latent A + mottle + veinbanding + latent C			
U. S.-Ore. 2331	+	moderate	90
Mild yellow-edge + crinkle + latent A + mottle + veinbanding			
U. S.-Ore. 2414	+	none	--
Mild yellow-edge + crinkle + latent A + mottle + veinbanding + latent C			
U. S.-Ore. 2414	+	severe	72
Mild yellow-edge + crinkle + veinbanding + mottle + latent A			
Northwest (clone 10)	+	mild	--
Mild yellow-edge + crinkle + veinbanding + mottle + latent A + latent C			
Northwest (clone 10)	+	severe	29

[a] + = Viruses introduced "recovered" on reindexing to proper indicators.
[b] Ninety days after date of inoculation.

caused such severe stunting of cultivated strawberries in such a relatively short time as latent C.

It was noted that some varieties and selections were less severely affected by this virus than U. S. Ore. 2707. Rockhill, Puget Beauty, and U. S.-Ore. selections 2528, 2592, 2678, and 2701, for example, were only mildly affected, indicating a degree of varietal tolerance to this virus.

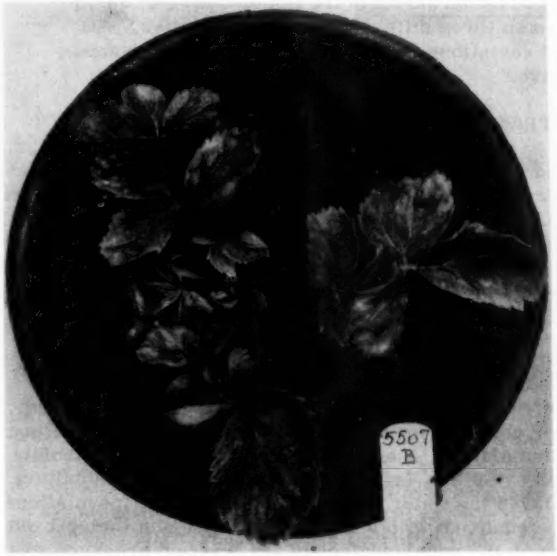

FIGURE 4. Severe dwarfing of Northwest (clone 10) infected with mild yellow-edge + veinbanding + mottle + crinkle + latent A + latent C viruses; inoculated by excised leaf-grafts; note severity of virus symptoms; photographed 169 days after date of grafting.

This virus apparently is indigenous in north-central and eastern United States. Its presence in other areas of the United States such as Arkansas where it is definitely known to be present (1) results primarily from the movement of infected plants from the eastern United States into other areas. However, it is noteworthy that Fulton (1) reported a case of movement of latent C to previously virus-free plants in Arkansas.

So far latent C virus has not been identified in commercial strawberry stocks west of the Rocky Mountains. Because of the rapid plant degeneration when this virus is combined with viruses already present in the western United States, it seems advisable not to invite potential trouble by planting eastern-grown plants.

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PIC

REACTION OF DIFFERENTIAL COTTON VARIETIES TO ISOLATES OF XANTHOMONAS MALVACEARUM IN NORTH CAROLINA

Bill B. Brodie[1] and W. E. Cooper[2]

Abstract

Sixteen isolates of Xanthomonas malvacearum from the major cotton-growing counties of North Carolina were tested on three differential cotton varieties. All isolates reacted as race 1. Observed variations in virulence of isolates appeared to be quantitative rather than qualitative.

INTRODUCTION

In 1953 Hunter and Blank (3) described a strain of Xanthomonas malvacearum (E. F. Sm.) Dows. which differed from the common strain in that it was capable of infecting resistant Acala cotton seedlings. Later this strain was designated race 2 and the common strain was designated race 1. Since the recognition of pathogenic races of X. malvacearum considerable emphasis has been placed on the occurrence and distribution of the different races (1). The present work investigated the possibility of the presence of more than one race of X. malvacearum in North Carolina.

MATERIALS AND METHODS

Sixteen isolates of X. malvacearum were obtained from diseased cotton leaves collected from 12 counties which represent the major cotton-growing area of North Carolina. The bacterium was isolated on nutrient-agar dilution plates. A single-colony culture of each isolate was obtained by using the method described by McNew (4). A 36-hour nutrient-broth culture of each isolate was diluted 50:1 with autoclaved tap water and used as inoculum. Inoculations were made with a 5-ml hypodermic syringe equipped with a 1-inch piece of tygon tubing 1 cm in diameter. The tubing was placed firmly on the under surface of the leaf and pressure was applied to the syringe. This treatment produced a water-soaked area on the leaf about 1/2 inch in diameter. Individual plant reactions were recorded 10 days after inoculation by using the grading system reported by Green and Brinkerhoff (2).

Differential cotton varieties used were as follows: Stoneville 2B, susceptible to all known races; Stoneville 20, resistant to race 1 and susceptible to race 2; Mebane B1, resistant to races 1 and 2. The differential varieties were grown in 6-inch pots and inoculated when 1 month old. Each isolate was tested on four leaves per plant on a total of six plants of each variety.

RESULTS AND DISCUSSION

All isolates infected Stoneville 2B but failed to infect Stoneville 20 or Mebane B1 (Table 1). Some variation in virulence was noted among the isolates. This variation appeared to be quantitative rather than qualitative. From the present study, race 1 of X. malvacearum appears to be the one prevalent in North Carolina. Since most of the cotton acreage in North Carolina is planted to a single variety, Coker 100W, which is susceptible to race 1, no selection pressure favors the build-up of a new race of X. malvacearum.

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Table 1. Reactions of 3 differential cotton varieties to 16 isolates of X. malvacearum.

Isolate no.	County	Stoneville 2B		Stoneville 20		Mebane B1	
		Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
1	Northampton	S[a]	S	R	R	R	R
2	Halifax	S	S	R	R	R	R
3	Franklin	S	S	R	R	R	R
4	Bertie	I	S	R	R	R	R
5	Pitt	S	I	R	R	R	R
6	Wilson	S	S	R	R	R	R
7	Wayne	S	S	R	R	R	R
8	Wayne	S	S	R	R	R	R
9	Sampson	S	S	I	R	R	R
10	Sampson	S	S	R	R	R	R
11	Cumberland	S	S	R	R	I	R
12	Hoke	S	S	R	R	R	R
13	Scotland	S	S	R	R	R	R
14	Scotland	S	S	R	R	R	R
15	Robeson	S	S	R	R	R	R
16	Robeson	S	S	R	R	R	R

[a] S = susceptible; I = intermediate in susceptibility; R = resistant.

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PIC

PROCEDURE AND EFFECTIVENESS OF THE BARLEY EMBRYO TEST FOR LOOSE SMUT USED IN NORTH DAKOTA[1]

Donald J. Morton, Everett Tool and Irvin K. Hagen[2]

Summary

Two hundred and ninety-five seed samples were evaluated by both embryo and field maturity tests. A correlation coefficient of 0.946 was obtained for the paired values, a figure easily significant at the 1% level. The embryo test used in North Dakota is considered a reliable indicator of Ustilago nuda-infected barley seed.

INTRODUCTION

A severe epiphytotic in 1959 of barley loose smut (Ustilago nuda (Jens.) Rostr.) in the Red River Valley created interest in developing a fast and reliable method for detecting infected seed. The embryo test was considered best adapted to this purpose, and a variation of this test combining features described by Simmonds (5), Russell (4), Popp (3) and Morton (1, 2) was used to test over 2400 seed samples from North Dakota and Minnesota during the winter of 1959-1960. In order to determine the reliability of this method, a comparison was made between seed infection percentages determined first by embryo and later by field maturity tests.

MATERIALS AND METHODS

The percentage of infected embryos in each sample was estimated by the following procedure:

1. Several hundred seeds were soaked for about 20 hours in 5% sodium hydroxide containing 0.05-0.1% Trypan blue.
2. The resulting mass was poured onto a series of screens of 4, 6, 8, and 14 meshes per square inch.
3. Embryos were collected from the bottom screen and placed in Petri dishes of lactophenol (1:1:1:5 phenol (melted), glycerine, lactic acid, and distilled water).
4. The lactophenol was boiled for several minutes, after which the embryos were poured into grooved dishes.
5. Embryos were examined with a dissecting microscope, and several hundred embryos were counted per sample. Infected specimens showed conspicuous blue mycelium predominantly in the scutella.

Two hundred and ninety-five of the seed samples evaluated by the embryo test were planted in field rows to establish what percentage of heads would be smutted. The seed represented samples from each of the following categories: high infection (10-35%), moderate infection (3-9.9%) and low infection (0-1%).

Table 1. Average percentage loose smut in barley as estimated by embryo and field maturity tests[a].

% smut infection	No. samples	Embryo test	Maturity test
0 - 1	98	0.5	0.7
3 - 9.9	102	5.1	5.3
10 - 35	95	14.3	14.5
0 - 35	295	6.5	6.7

[a]Correlation coefficient for 295 samples = 0.946.

1Research supported in part by the Malting Barley Improvement Association.
2Assistant Plant Pathologist, North Dakota Agricultural Experiment Station and Deputy Commissioners, North Dakota State Seed Department, respectively.

Seeds were planted densely to discourage tillering, and plantings were made late in the season to avoid seedling blights. Only 100 heads were counted for each of the samples because of the large number of seed lots tested.

RESULTS

The results are condensed in Table 1. In all cases, the embryo test closely predicted the percentage of smutted heads that grew from each sample. A correlation coefficient of 0.946 was calculated for the 295 paired values, a figure easily significant at the 1% level.

It is concluded that the embryo test used in North Dakota effectively estimates the percentage of U. nuda infection in barley seed lots.

There was a slight increase in smut percentages based on field readings over those obtained with embryo counts. Occasional lightly-infected embryos may have been overlooked, since many of the embryo counts were made under routine conditions by non-professional employees.

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PIC

EFFECT OF HIGH-TEMPERATURE WATER VAPOR ON SOIL ORGANISMS[1]

Leo Campbell and Wilbur D. Courtney[2]

Abstract

Experiments indicate that certain soil-borne organisms can be controlled by momentary treatment of the soil mass with water vapor super-heated to 800° to 850° F while being agitated and pulverized. This treatment differs from conventional soil sterilization in that here killing is apparently due to instantaneous contact of the soil organisms and selective absorption of heat units by them without significantly raising the temperature of the treated soil.

The use of high-temperature water vapor for treating soil as reported here was originated by Burr B. Elliott of Soap Lake, Washington more than 20 years ago. He hoped to control soil-borne fungi, insects, and nematodes by exposing agitated and pulverized soil to momentary contact with water vapor at temperatures of 500° to 900° F. This type of treatment differs from the conventional soil sterilization in which the soil is heated in place by steam to 180° to 212° F for 30 minutes or more.

The Isaacson Iron Works of Seattle, Washington[3], in cooperation with Mr. Elliott, designed and built a huge machine, the "Ironovator." This machine scooped up the top several inches of soil, passed it through a large tunnel where it was broken up, exposed to water vapor, and deposited back into the "furrow." Observations made during 1945-1946 on the operations of this machine indicated considerable variation in results. Nematode populations and certain plant diseases, however, were often materially reduced by the treatments. It was evident from these results that certain tests should be made preliminary to further field plot experiments. With this in mind, Mr. Elliott designed and constructed a stationary laboratory model in 1954, which he delivered to the Western Washington Experiment Station for testing.

This laboratory model used a rapidly revolving studded cylinder to pulverize the soil fed by an auger from a hopper. Soil was exposed to the water vapor as it fell into a container at the bottom of the treatment chamber. Results of the first tests made with the machine were inconsistent, apparently because neither the temperature of the water vapor nor the flow of the soil from the hopper was sufficiently constant. The machine was then modified by substituting continuous slits for the individual orifices which admitted water vapor into the supply pipes. The results with this improved machine are given in Table 1.

Table 1. Results of experiments in the greenhouse with soil treated with hot water vapor produced by the laboratory Ironovator in 1957[a].

Name of disease	Treated[b]			Untreated[c]			% reduction in disease	% reduction in nematodes
	P[d]	D	N	P	D	N		
Fusarium root rot of beans	35	0	0	49	49	554	100.00	100.00
Sclerotinia stem rot of beans	44	6	0	39	16	521	64.33	100.00
Smut of onions	35	1	21	169	21	5392	94.04	99.61

[a]Soil potted and planted to seed the day following treatment.
[b]Treated at 800° F for 2 minutes. Average rise in temperature of soil due to treating was 41° F.
[c]Run through machine without heat.
[d]P = number of plants, D = number of diseased plants, N = number of nematodes in a standard sample of the soil used for the disease test.

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[2]Plant Pathologist, Western Washington Experiment Station, and Nematologist, United States Agricultural Research Service, Puyallup, Washington, respectively.
[3]Mention of trade or company names is made for identification purposes only and does not imply endorsement by the United States Department of Agriculture or Washington State University.

Table 2. Field experiments on the effect of hot water vapor from a field model Ironovator on certain diseases and nematodes, 1959.

Disease[a]	No. times ironovated[b]	% soil moisture after treatment	soil temp. after treatment (° F)	No. of nematodes[c]	% reduction in nematodes	% disease	% reduction in disease
Root rot of beans	0	18.24	82	2272	--	88.77	--
	1	18.77	108	2269	0.01	90.20	0.01
	2	16.41	131	10	99.56	--	--
	3	18.19	126	0	100.00	41.90	56.43
	4	16.09	142	0	100.00	--	--
	5	16.63	138	0	100.00	36.03	62.53
Club root of cauliflower	0	16.30	--	977	--	100.00	--
	1	16.27	104	825	15.35	96.66	3.33
Smut of onions	0	12.40	--	3040	--	0	--
	1	12.50	102	1076	64.69	0	0
Foot rot of peas	0	11.09	--	458	--	100.00	--
	1	11.81	95	59	82.77	100.00	0

[a]Soil planted to seed of beans, onions, peas, or plants of cauliflower from disease-free plant bed. Each plot known to be infested with respective pathogen.
[b]Water vapor averaged between 800° and 850° F. Machine moved at about 2 miles per hour and made a cut about 11 inches wide and 4 inches deep. 0 indicates soil was treated with machine without heat. Other treatments followed one another without delay.
[c]Number of nematodes in standardized samples of soil from plots used for disease tests.

In addition to the results given in Table 1, the machine showed some promise of controlling club root and wire stem of cole crops but the results with Ascochyta foot rot of peas and Verticillium wilt of potatoes were all negative.

An experimental field model was designed and constructed in 1959 by the Skagit Steel and Iron Works of Sedro Woolley, Washington, in cooperation with Mr. Elliott. This machine could be pulled by a medium-sized farm tractor, and was otherwise much more maneuverable than the huge 1945 model. With it the soil was pulverized by modified rotary tillers and exposed to the water vapor. The engineers were confident that this machine could duplicate in the field the results of the laboratory model, be manufactured and operated at reasonable costs, and have a maximum treating rate of 1/3 acre per hour. This machine was designed to deliver more water vapor per unit of soil exposed than the laboratory model did, but the maximum operating temperature of the vapor was only about 600° F and results of experiments with it failed to show any evidence of nematode or plant disease control.

Another machine was then built with the same fundamental design, but it handled only one-half the soil cut of the former machine and operated at higher temperatures, up to 850° F. Data from soil treated with this machine are listed in Table 2.

The striking results obtained with nematodes and certain diseases with the laboratory model seem to warrant further investigations with this type of treatment, beginning with testing methods of obtaining better contact of organisms in the soil with various high-temperature water vapors.

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PIC

A MODIFIED METHOD FOR CULTURING ELM SAMPLES[1]

John H. Hart[2]

Summary

An elm-extract medium was developed which allows elm samples from trees suspected of having Dutch elm disease or other elm pathogens to be cultured without surface sterilization. Air or surface contaminants grew slowly enough to be of no consequence. Coremia (synnema) of Ceratocystis ulmi (Buis.) C. Moreau were produced in abundance in 4 to 6 days.

Other wilts of elm have symptoms similar to those of Dutch elm disease caused by Ceratocystis ulmi. Consequently positive diagnosis must be made by culturing samples from the diseased host. Most culturing has been done on PDA. Both the pouring of the plates and their subsequent use must take place under sterile conditions. Surface sterilization of small-sized elm samples in experimental work often results in killing both contaminants and C. ulmi. A new technique was therefore devised whereby samples suspected of containing C. ulmi could be cultured without surface sterilization.

In the process of rejuvenating some cultures of C. ulmi on elm-extract agar, a ring of coremia commonly developed around the inoculum. Since coremia are a diagnostic characteristic of this fungus, the elm-extract medium was investigated further to determine its usefulness as an identifying medium.

MATERIALS AND METHODS

The elm-extract medium used to culture samples without sterilization was composed of the following materials: 120 grams elm sawdust or shavings, 2400 ml distilled water, and 40 grams agar. The shavings were taken from living trees and included bark, sapwood, and heartwood. The shavings were added to approximately 1500 ml distilled water and boiled gently for 10 minutes. The supernatant liquid was strained through screen wire. The remaining sawdust was washed with distilled water which, in turn, was strained into the first filtrate. The amount of distilled water used was sufficient to bring the total volume of filtrate to 2400 ml. For ease in pouring the plates, the filtrate was divided equally into ten 500-ml Erlenmeyer flasks each containing 4 g of agar. The flasks were put in a steam bath until the agar had melted, transferred to an autoclave and sterilized for 15 minutes at 15 pounds' pressure. The liquid medium was poured into sterilized Petri plates under sterile conditions yielding 110 to 130 plates.

Autoclaving the medium may be omitted. After the agar had been melted and mixed well with the filtrate, the medium could be poured directly into unsterilized Petri plates. Little additional contamination was encountered using this method. Plates which were not used immediately were stored at 6° to 7°C until needed. Both autoclaved and non-autoclaved plates have been stored successfully for 2 to 4 weeks. In addition to the elm-extract agar, water agar (1 g agar/60 g distilled water) was prepared without sterilization.

General procedure for inoculating plates was to peel the bark from the portion of the branch to be cultured. The most satisfactory branch diameter was 0.5 to 1.2 cm. Four cylinders approximately 0.5 cm in thickness were cut with hand pruning shears and allowed to fall on a piece of cheesecloth soaked in a 10% Clorox solution. Air currents were kept at a minimum. Cylinders were transferred to plates with tweezers and were pushed slightly into the medium with one of the cut surfaces up. Plates were opened as little as possible and cylinders were transferred from cheesecloth to plates as quickly as was feasible. Even though the medium and plates were not sterilized, the above precautions were taken since some air and surface contaminants retarded the growth and production of coremia. The water agar plates were inoculated in a similar manner.

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[2]Recipient of a 1960 National Science Foundation Summer Fellowship for Graduate Teaching Assistants.

To test the suitability of the elm-extract medium under more extreme conditions, plates were made with no attempt to reduce contamination. Five plates each were inoculated in the following places allowing the cylinders to fall on whatever surface was present.

1. Desk top
2. Laboratory bench top
3. Walk-in transfer chamber
4. Front steps of the Botany Building
5. Storeroom work table
6. Greenhouse work bench
7. Two other laboratories in the building where culture work is frequently being done and air contaminants were thought to be high

In addition to the above plates, a series was inoculated without any sterilization on an open laboratory bench by two high school students working as laboratory technicians.

All inoculated plates were incubated at 22° to 25°C for 5 to 7 days.

RESULTS AND DISCUSSION

The numerous plates prepared using the general procedure to prevent contamination were almost free of unwanted organisms. Coremia from the cylinders were noticeable in 4 days and abundant in 6 to 7 days with all isolates tested to date.

Although the plates made by the preceding procedure were the most successful, the plates exposed in the different locations and those prepared by the two technicians proved very satisfactory. Coremia were produced in all plates and on all but two cylinders in 4 to 6 days. These two apparently had some other fungus present which inhibited the growth of C. ulmi.

C. ulmi appeared to be growing from all the cylinders on the water agar plates. Mycelial growth was more difficult to observe against the light colored water agar than against the light brown elm-extract medium. Coremia were present on some, but not all, of the cylinders. Coremia production, when present, was usually sparse. No coremia were observed growing from the surface of the water agar but were observed frequently on the surface of the elm-extract agar.

Elm-extract medium should be of use to city and state laboratories which now culture elm samples. At the author's suggestion, a city laboratory has used this medium for further study on the growth habits of C. ulmi[3]. Abundant production of coremia is an aid in identification, and use of this medium reduces the time needed for culturing and identifying C. ulmi. Water agar may prove satisfactory if no elm sawdust is available. Addition of the elm extract is a simple procedure, however, and greatly improves the medium.

Both Verticillium albo-atrum Reinke & Berth. and Dothiorella ulmi Verrall & May have been identified using this medium under sterile conditions.

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PIC

CONTROL OF BANANA FRUIT-SPOT ("SPECKLE") CAUSED BY DEIGHTONIELLA TORULOSA (SYD.) ELL.

D. S. Meredith[1]

Fruit-spot ("speckle," "swamp-spot") of Jamaican Lacatan bananas is caused by Deightoniella torulosa (2, 4, 5), a common saprophyte on dead or dying banana leaves, bracts and other "trash." Dead leaves hanging from the pseudostem appear to be the most abundant source of inoculum of this fungus (5). The author considers that removal of dead or dying banana "trash" from the plantation may result in appreciable reduction of fruit-spot. Some evidence in support of this suggestion has been obtained during discussion with several growers in Jamaica. It is well known to growers that fruit-spot is most severe following periods of heavy and continuous rainfall. This is due to the facts that spore germination and infection are optimal when the fruit surface is covered with a film of water (5), and that spore formation, liberation and dispersal is favored by such weather conditions (3). One grower in particular remarked upon the fact that removal of as much "trash" as possible before heavy rains resulted in almost perfect control of fruit-spot; weed removal was also beneficial. Uncleared plantations to the leeward side showed a high incidence of spotting. Arrangements have now been made to test the effect of plantation hygiene on the incidence of fruit-spot. It is of importance also to know the amount of extra labor costs and to compare them with expenses involved in using possible alternative control measures such as fungicidal treatment or bunch-protecting plastic bags (1).

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PIC

AECIAL STAGE OF BEAN RUST FOUND IN NEW YORK STATE

E. D. Jones[1]

The aecial or cluster-cup stage of the bean rust fungus Uromyces phaseoli var. typica was observed for the first time in New York State. It was found on pole beans in a garden at Hankins, Sullivan County, New York. Excellent slides and negatives of the specimens were made by H. H. Lyon, Photographer, Department of Plant Pathology, Cornell University.

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